SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

JULY 1901.

GENERAL PHYSICS.

1235. *Form of Volumometer.* **F. W. Jones.** (Chem. News, 83. pp. 100-101, March 1, 1901.)—The author describes a form of volumometer, designed for the determination of the specific gravity of explosives containing ingredients soluble in water. The instrument consists of a gas burette with stopcock, connected at the lower end with a reservoir of mercury and at the upper end with a bottle of small capacity, resting on a spring platform. This bottle has another opening in the stopper fitted with a stopcock. The method of experiment to determine the specific gravities is described, and a table of results obtained with the apparatus is given. From this table the author concludes that it is possible by such an apparatus to obtain specific gravities accurate to the second place of decimals. W. C. H.

1236. *Viscosity of Water.* **E. R. Drew.** (Phys. Rev. 12. pp. 114-120, Feb., 1901.)—The determination of the viscosity of water which is here described was carried out by means of an apparatus which consists essentially of two vertical coaxial cylinders, the outer capable of rotating at any desired speed, while the inner, which is closed at the ends, is suspended by means of a torsion wire between agate bearings in the axis. The liquid used is contained in the space between the two cylinders. The apparatus was constructed by E. L. Johonnott under the direction of Professor Michelson, and it was not known at the time that Professor Perry had previously made use of the idea of coaxial cylinders for the same purpose. Perry has given the complete mathematical theory. (See "Liquid Friction." Phil. Mag. 435-441, 1893.)

The author found for the value of the coefficient of viscosity of water, μ, at 20° in two experiments, (1) $\mu = 0{\cdot}01023$, (2) $\mu = 0{\cdot}01020$, expressed in dynes.

The value deduced from the observations of Poiseuille by the formula given by Helmholtz is $\mu = 0{\cdot}0101$. J. J. S.

1237. *Normal Component of Gravitation at Sea-Level.* **F. R. Helmert.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 14. pp. 328-336, March 14, 1901. Abstract of the report presented by the author to the International Geodetic Conference at Paris, September, 1900.)—This report concerns pendulum observations made during the nineteenth century all over the globe. Values for g from small islands in the deep sea and also from high mountains are excluded. Continental values and those on coast lines are kept apart; they agree closely, however. The reductions to sea-level are made on the Vienna system of the Militär-Geographische Institut of Vienna. The final means are:

$$\gamma_0 = 978{\cdot}046 \left\{1 + 0{\cdot}005302 \sin^2\phi - 0{\cdot}000007 \sin^2 2\phi\right\} \text{ cm.}$$

or—

$$\gamma_0 = 980{\cdot}332 \left\{1 - 0{\cdot}002644 \cos 2\phi + 0{\cdot}000007 \cos^2 2\phi\right\} \text{ cm.}$$

with a reciprocal ratio $1 : \alpha = 298{\cdot}3$. H. B.

1238. *Variation of the Rigidity of Vulcanised India-Rubber with Tension.* **T. C. Hebb.** (Nova Scotian Inst., Trans. 10. pp. 273–286, 1900.)—The author describes experiments undertaken for confirming or otherwise some experiments made by W. A. Macdonald at Dalhousie College that the rigidity (kinetically determined) of a fresh or partially fatigued vulcanised rubber cord, when subjected to increasing tension, at first diminished, then reached a minimum, and finally increased; while in the case of a sufficiently fatigued cord, the minimum point seemed to disappear. These results were confirmed; the author also found that increase of tension in a cord that has been under tension for some time immediately decreases the rigidity, but that if the cord is left under the tension the rigidity increases again. E. C. R.

1239. *Deductions from Capillary Phenomena.* **A. Einstein.** (Ann. d. Physik, 4. 3. pp. 513–523, March, 1901.)—By thermodynamical reasoning and the experimental facts of the phenomena of capillarity the author puts forward the view that the energy of the surface of a liquid is of the nature of potential energy expressible by a certain equation. In this equation occurs a coefficient, c_a, characteristic of the particular atom to which it refers. After passing in review a number of organic compounds, it is concluded that with increasing atomic weights the value of the constant c_a usually increases, but not always, and not proportionally. It is hoped that further researches in this direction will clear up the subject. E. H. B.

1240. *Theory of Solids.* **W. Voigt.** (Ann. d. Physik, 4. 3. pp. 567–591, March, 1901.)—A criticism of the older views as to solids. The author commences by attacking the theory which assumes that the behaviour of a solid is expressible by a few constants throughout its substance, including the *surface.* He next objects to the laws of homogeneous strain being applied without modification to cases of heterogeneous strain. The remainder of the article is devoted chiefly to a discussion of Mohr's rule, and the conclusion is drawn that we are still in need of much searching experiment before a satisfactory theory of solids can be framed. E. H. B.

1241. *Mechanical Oscillations in a Wire Carrying a Current.* **O. Viol.** (Ann. d. Physik, 4. 4. pp. 734–761, April, 1901.)—A discharge is sent from an influence machine through a spark-gap and then along a stretched wire. Nodes and internodes are shown in the wire by the luminosity of the former. When the wire is mechanically vibrated the luminous nodes appear according to the usual laws. The wire must be thin to show these effects. Photographs are reproduced showing with great clearness the whole node systems.

P. E. S.

1242. *A Theorem on Fourier's Series and its Application to Geophysics.* **A. Nippoldt.** (Phys. Zeitschr. 2. pp. 363–365, March 16, 1901.)—The author succeeded in showing that the field to which, according to Schuster and Bezold, are to be ascribed the daily variations of the earth's magnetism, consists of two parts, of which one corresponds to the solar the other to the terrestrial effect. Both have a period of 24 hours. The solar portion is the first term in the Fourier series, the terrestrial portion includes all the other terms.

The writer gives a simple theorem, as useful for this and other applications to geophysics. He calls it the coefficient theorem. Let—

$$f(t) = a_0 + \Sigma p_n \cos nt + \Sigma q_n \sin nt.$$

Further let $f(t)$ be a linear function of the independent variable, $x_1, x_2, \ldots x_m$, and let x_m be capable of expansion in the form—

$$x_m = (a_0)_m + \Sigma (p_n)_m \cos nt + \Sigma (q_n)_m \sin nt.$$

Then the problem is to find what functions p_n, q_n are of $(p_n)_m, (q_n)_m$.

From the independence of $x_1, x_2 \ldots x_m$ it follows that $f(t) = \Sigma_1^m c_m x_m$. whence—

$$a_0 = \Sigma_1^m c_m (a_n)_m,$$
$$p_n = \Sigma_1^m c_m (p_n)_m,$$
$$q_n = \Sigma_1^m c_m (q_n)_m.$$

In other words, the amplitude of the *n*th excited wave depends only on the *n*th exciting wave. The application of the theorem to several meteorological questions is explained.

S. H. B.

1243. *Parameters of Crystal Physics and Directed Quantities of a Higher Order.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr. Math.-Phys. Klasse, 4. pp. 355–379, 1900.)—The author divides the magnitudes which form the subject of this paper into orders, thus—

First order, the *vectors* x, y, z.

Second, the *tensors* $x^2, y^2, z^2, \sqrt{2}yz, \sqrt{2}xz, \sqrt{2}xy$.

Third, $x^3, y^3, z^3, \sqrt{3}x^2y$, and six other corresponding products, and so on to the fourth order.

The following theorem is fundamental. If a scalar S be any arbitrary function of a system of orthogonal variables, then every first differential coefficient according to one of these variables is symmetrical in relation to the transformation properties of these variables. An example is given wherein S is a function of $X_1 \ldots X_n$, and these variables are transformable into $Y_1 \ldots Y_n$ by the relations—

$$X_h = \Sigma_i a_{hi} Y_i, \quad Y_\kappa = \Sigma_\gamma a_{\gamma\kappa} X_\gamma.$$

Thus we have—

$$\frac{dS}{dY_1} = \frac{dS}{dX_1}\frac{dX_1}{dY_1} + \&c.,$$

and therefore—

$$\frac{dS}{dY_\kappa} = \Sigma_\gamma a_{\gamma\kappa} \frac{dS}{dX_\gamma};$$

a special case of importance is when S is a linear function.

The author discusses the separate orders and gives known physical examples. Five principal cases are discussed.

First a scalar linear in three vector components, $S = h_1V_1 + h_2V_2 + h_3V_3$. Here h_1, h_2, h_3 are themselves vectors in directions of the co-ordinate axes. As an example of this form, in thermoelectricity the free energy per unit of volume corresponding to a small change of temperature τ is given by the expression—

$$\xi = -\tau(r_1X + r_2Y + r_3Z),$$

where X, Y, Z are the components of the electric field. Hence are obtained the components of electric moment,

$$\alpha = -\frac{d\xi}{dX} = r_1\tau, \quad \beta = r_2\tau \quad \gamma = r_3\tau.$$

The resultant of r_1, r_2, r_3 is the moment corresponding to unit increase of temperature.

The second case is that of a scalar linear in six tensor components. This is illustrated by thermomechanical phenomena in crystals.

Then thirdly a scalar bilinear in twice three vector components of the form—

$$\begin{aligned} S = {} & U_1(n_{11}V_1 + n_{12}V_2 + n_{13}V_3) \\ & + U_2(n_{21}V_1 + n_{22}V_2 + n_{23}V_3) \\ & + U_3(n_{31}V_1 + n_{32}V_2 + n_{33}V_3), \end{aligned}$$

which is a relation of frequent occurrence in the theory of crystals.

The fourth case treated is that of a scalar bilinear in three vector and six tensor components, and the fifth a scalar bilinear in twice six tensor components.

The writer concludes that the parameters of crystal physics are generally referable to directed magnitudes of the first to the fourth order, and that in many cases these magnitudes have a distinct physical significance. S. H. B.

1244. *Propagation of Waves through a Heterogeneous Medium of Lamellar Structure.* **N. Kasterin.** (Archives Néerlandaises, 5. pp. 506–515, 1900.)—In treating this very difficult problem the author begins with the simplest conceivable case. We are to suppose a series of laminæ containing gas numbered consecutively 1, 2 . . . N. For the first lamina a is the thickness, ρ_1 the density of gas within it, Ω_1 the velocity. For the second lamina a, ρ_1, Ω_1 are replaced by b, ρ_2, Ω_2, and so on. Acoustic waves only are first treated. The laminæ are all at right angles to the axis of x. The period, T, of the oscillation in any lamina is a function of x and of the time only. The co-ordinates of the edges of the laminæ are in order x_0, x_1, x_2, &c., so that if x be the co-ordinate of any point within the $(m+1)$th lamina, $x_{2m} \leqq x \leqq x_{2m+1}$. If ϕ_{2m+1} be the velocity potential, ϕ_{2m+1} satisfies the equation—

$$\frac{\partial^2\phi_{2m+1}}{\partial x^2} + k_1^2\phi_{2m+1} = 0.$$

Similarly—

$$\frac{\partial^2\phi_{2m+2}}{\partial x^2} + k_2^2\phi_{2m+2} = 0.$$

Here—

$$k_1 = 2\pi/T\Omega_1 \quad k_2 = 2\pi/T\Omega_2.$$

Hence, making use of the terminal conditions for each lamina we obtain a system of $2(N-1)$ linear differential equations containing 2N unknown constants, and it is then proved that for all possible values of N_1 and for arbitrary values of k_1a, k_2b, &c., it is always possible to reduce these to six linear differential equations with eight unknown constants.

Our author defines a function k' (equation 18) by—

$$\cos k'(a+b) = \cos k_1a \cos k_2b - \tfrac{1}{2}\left(\frac{k_1\rho_2}{k_2\rho_1} + \frac{k_2\rho_1}{k_1\rho_2}\right) \sin k_1a \sin k_2b.$$

From which the dependence on k' of the period T can be found. Then he makes $k' = n(1 - i\epsilon)\Omega T_1$ where $i = \sqrt{-1}$, and ϵ is the *absorption coefficient.* From the equation thus obtained the curves can be drawn showing graphically the phenomena of absorption and dispersion.

It is remarked that the formulæ obtained hold also for electromagnetic waves, if by ϕ (which is the velocity potential in the investigation of the present paper) we understand the electric force at right angles to the axis of x, *i.e.*, to the direction of propagation. Also that by the analogy between the passage of waves in a heterogeneous medium and that of light waves, the theory developed in this paper can be applied to explain the acoustic opacity of the atmosphere and Lipmann's colour photography. S. H. B.

1245. *Physical Constitution of the Sun.* **K. Birkeland.** (International Physical Congress at Paris, Report, 3. pp. 471–487, 1900.)—*Section* I.—Sun-spot observations are discussed with the view of testing the hypothesis that the spots are manifestations of periodic eruptions from persistent centres of eruption in a relatively stable nucleus rotating uniformly in the interior of the sun. A remark of G. H. Darwin's is quoted, to the effect that we have no data as to the mechanical properties of matter at 10,000° F. and a pressure of many tons to the square inch, that a gas under such conditions may have the density of mercury and rigidity of granite. The writer considers that facts support the hypothesis, but that further observations at the next maximum are needed to confirm it. He makes the period of rotation 25·149 days.

Section II.—The same observations are here examined with the object of determining whether the influence of the planets Mercury, Venus, and Jupiter can be traced. The writer finds that it can in spite of the smallness of the planets' attraction, and he considers that this tends to confirm the above hypothesis of a quasi-solid solar nucleus. A. E.

1246. *Solar Constant.* **A. Crova.** (International Physical Congress at Paris, Report, 3. pp. 453–470, 1900.)—The means employed for measuring the intensity of the sun's thermal radiation at the earth's distance, and the formulæ used in reducing the observations, are discussed at length. The writer infers that the true value of this "solar constant" must be at least 3 therms per minute per square centimetre, and may be found to be 4 therms or more as observing conditions improve. The better the conditions, and the higher the elevation, the greater the values obtained hitherto. A. E.

1247. *Heat of Stars and Planets.* **E. F. Nichols,** with **A. L. Colton** and **C. E. St. John.** (Astrophys. Journ. 13. pp. 101–141, March, 1901.)—The author describes a series of observations of the heat radiation of Arcturus, Vega, Jupiter, and Saturn made at the Yerkes Observatory in the summers of 1898 and 1900. A very detailed account is given of the heat-measuring instrument used, which was of the same type as the compensating torsion radiometer, of which a description has appeared (Physical Review, iv. 297; also Wied. Ann. 60. 401, 1897). The apparatus was tested upon two candles at stations at different distances (2,500 and 4,500 feet), so far away that the radiometer sensitiveness could be determined with the same mirrors used in the star observations. The radiometer was found to be twelve times as sensitive as the radiomicrometer of Boys (Proc. R. S. 47. 480, 1890), which gave a deflection of 60 mm. for a candle 60 inches distant. The concave mirror was also larger—24 inches diameter as against 16 inches. Thus the radiometer combined with its mirror, whenever the full aperture could be utilised, was over twenty-six times as sensitive as the apparatus used by Boys.

The small amount of heat detected in the present observations readily accounts for the negative result of the radiomicrometer measurements. The following are the relative thermal intensities of the means, reduced to the zenith, expressed in 10^{-8} metre candles: Vega, 0·51; Arcturus, 1·14; Jupiter, 2·38; Saturn, 0·37. The ratio of the zenith photometric intensities is: Vega : Arcturus : Jupiter :: 1 : 1 : 7·8. Thus Arcturus would appear to have a proportionately more intense infra-red spectrum than Vega. Although the results so far gained are to be considered only in the roughest sense quantitative, they are useful in supplying a basis for calculating the necessary aperture of mirror and suggesting further refinements in the radiometer. A 5-foot concave mirror could be effectively employed, even with the same radiometer. A. E.

1248. *Reduction of Measures of Stellar Photographs.* **H. G. v. d. Sande Bakhuyzen.** (Archives Néerlandaises, 5. pp. 542–548, 1900.)—This paper chiefly concerns those connected with the work of the International Photographic Star Chart. When deducing the right-ascensions of stars from their co-ordinates referred to rectangular axes on the plate, calculators are cautioned to notice that δ, the declination of the origin, has different meanings in different formulæ of reduction. A simplification in the formulæ is suggested by taking as axis of y on the plate, instead of the apparent hour-circle, its position after correcting for refraction and aberration. A. E.

1249. *Danish Polar Light Expedition to Iceland, Winter* 1899–1900. **A. Paulsen.** (International Physical Congress at Paris, Report, 3. pp. 438–452, 1900.)—A brief account of this expedition has already been given by Neesen [see Abstract 351 (1901)]. The strong auroral rays [Abstract No. 999 (1900)] appear on the plates even when no aurora is visible. In determining the electric potential of the atmosphere, a metallic disc collector, 13 cm. in diameter, was used, whose surface was covered with filter paper rubbed with a powder supplied by Curie, which emits Becquerel rays; thus the disc was brought to the potential of the air surrounding it. The ascending wind currents on the mountain observatory, at an altitude of 1,200 m., were so rapid that the barometer fell by 12 mm. within a few seconds; these pressure variations were painful to the ears of the observers. The variations in the electric potential were less marked at this altitude than at the other observatory, 50 m. above sea-level; auroræ had an effect only when near the zenith. The electric discharge was determined by means of the metallic cylinder of Elster and Geitel; the discharges proved different for negative and for positive electricity. H. B.

1250. *Fog Studies on Mount Tamalpais.* **A. G. McAdie.** (Monthly Weather Rev. 29. pp. 24–25, Jan., 1901.)—Two photographs are given of fog billows. The wave-lengths were estimated as varying between 100 and and 2,000 m. The fogs and billows distinctly interfere with the audibility of the siren signals. [See further Abstract No. 602 (1901).] H. B.

1251. *Eclipse Cyclone of the Solar Eclipse of May* 28, 1900, *and Diurnal Cyclones.* **H. H. Clayton.** (Amer. Acad., Proc. 36. pp. 307–318, Jan., 1901.)—The penumbra, or entire eclipse area, had a diameter of about 5,000 miles; the eclipse travelled with a velocity of 2,000 miles an hour. The wind and temperature observations from stations all over the southern and central portions of North America indicate an outflow of wind from around the umbra and an inflow around the border of the penumbra. These winds were reversed in direction as the umbra moved from the western over to the eastern coast of the United States. The synoptic chart shows an anticyclonic condition around the centre of the eclipse, extending to a distance of about 1,500 miles from the umbra; and outside this area a cyclonic circulation, 1,000 miles in width, extending beyond the edge of the penumbra. An elliptical area of cold followed the umbra, lagging behind by 500 miles. This temperature depression amounted at Wadesboro', in N.C., to 8° F. at 9 a.m.; it was less at stations where the sky was cloudy and diminished with the height above the sea. The curve of Napier Denison's ærograph at Toronto marks a barometric depression during the eclipse period, with an upward swell, shortly preceding the middle of the eclipse, and further a ring of high barometric pressure just before the beginning and after the end of the eclipse, and thus surrounding the umbra. The central swell was more marked at stations in the path of totality; it is due to the increased density of cold air, and on it depends the outflow of air surrounding the umbra. The barometric records are in perfect agreement with the pressure distribution, demanded by the wind circulation, and the phenomena are those of a cold air cyclone of Ferrel (with a cold centre, as distinct from a hot centre cyclone), which is here directly caused by a fall of temperature and not complicated by condensation of vapour, nor the meeting of air currents. This eclipse cyclone moved with a velocity of 2,000 miles an hour, without any apparent dynamic lag due to the inertia of the air. Any given particle of air, moving with the velocity of the eclipse winds, could not have travelled more than 5 miles during the passage of the eclipse, and we have, therefore, a certain analogy to a wave motion. Cyclones can thus develop and dissipate in the air with a wonderful rapidity and move with their originating cause, and not only by drifting. The author explains the double period in the diurnal variations of the air pressure by two diurnal cyclones, the one developed by the cold of the night, the other by the heat of the day. These cyclones move from east to west (contrary to the ordinary cyclones of the temperate zones) with a velocity which is 1,000 miles per hour at the equator and decreases towards the poles. The hypothesis would also account for the third barometric maximum in high northern latitudes during the winter.

H. B.

1252. *Diurnal Periodical Oscillations of the Earth at Triest.* **E. Mazelle.** (Akad. Wiss. Wien, Sitz. Ber. 109. 1. pp. 527–651, 1900.)—This paper, essentially tabular, deals with the daily movements of the photographic recording triple horizontal pendulum of Rebeur-Ehlert [see Abstract No. 2398 (1900)] at Triest for the year September 1898–99. The pendulum is mounted on a limestone pillar, 70 cm. long, 60 cm. wide, 130 cm. high, resting in the basement of the Observatory on cement and sandstone over sandstone rock. The three pendulums show one diurnal period (one maximum and one minimum) for the summer months, and a double period for the months November to March. The resulting diagrams for the movements of the pillar are elongated ellipses with a major axis from E. 20° N. to W. 20° N. for the summer months and irregular curves for the winter months. H. B.

1253. *Damping Seismological Instruments.* **O. Hecker.** (Zeitschr. Instrumentenk. 21. pp. 81–83, March, 1901.)—The author attaches to the horizontal axis of a pendulum an aluminium cylinder, 7 cm. in height and 3·5 cm. in diameter, and surrounds this cylinder by another stationary one, leaving an annular space, 4 mm. in width, between the two cylinders. Vertical air currents are prevented by mica plates. Comparative diagrams demonstrate a very remarkable effect of this damping. An undamped pendulum of the same type marked some fresh impulses of an earthquake wave by a diminution in the amplitude of the oscillations, and others by a gradual increase in the amplitude, neither of which probably had any existence. H. B.

1254. *Theory of Atmospheric Condensation on Mountains.* **F. Pockels.** (Ann. d. Physik, 4. 3. pp. 459–480, March, 1901.)—Where a ridge of mountains rises from a plane, the slope exposed to the predominating winds receives more rain than the other slope and the plane. The author deals quantitatively with the problem, and bases his calculations on the Hertz tables for adiabatic changes in moist air. For a mountain rising with a gentle slope to 950 m. above the plane the maximum condensation would, when the plateau-like top of the mountain is below the base of the clouds, fall on the spot where the gradient is a maximum; the upper half of the slope would receive comparatively less rain; the lower half and even the plane adjoining the foot of the mountain more than we might expect. No definite allowance can be made in these calculations for the transport of condensed moisture within the horizontal air currents, whereby the maximum deposit is shifted more towards the top. If the mountain reaches into the clouds, the condensation will essentially depend upon the slope and follow a cosine law. So far the author has presumed that the temperature distribution in the air currents which strike the mountain is identical with that which results in an ascending air current This does not agree with balloon observations. Bearing this point in mind, the author finally calculates the winter and summer rainfalls for four slopes, culminating at heights between 2,940 and 5,100 m. There is always a zone of maximum condensation, and in general the slope is of greater influence than the absolute elevation. Observations made on high mountains would confirm these conclusions. H. B.

1255. *Line Integrals in the Atmosphere.* **F. H. Bigelow.** (Monthly Weather Rev. 28. pp. 535–537, 1900.)—The paper by Bjerknes [Meteorolog. Zeitschr., March and April, 1900; Abstract No. 1406 (1900)] has been criticised by M. Möller (*ibid.*, June, 1900), to which Bjerknes replies (*ibid.*, Nov., 1900); and J. W. Sandström has applied the theory of Bjerknes to cyclones (Swedish Acad., Jan., 1900). The author discusses this latter paper, and shows that, instead of computing the work integral around the circuit by means of the densities derived from observations *in situ* (by ascensions), we can measure the velocities of the air motion at four points by triangulation. The upper and lower point-pairs need not necessarily be on the same isobar. The Report of the Chief of the Weather Bureau on International Cloud Observation would contain material in proper form for such computations. H. B.

1256. *Squalls and Secondary Depressions.* **E. Durand-Gréville.** (Revue Scientif. 15. pp. 263–269, March 2, 1901.)—This paper discusses the squalls of Abercromby. A centre of depression is surrounded by concentric isobars with peculiar V-shaped prominences, the V of the consecutive isobars lying on a curved or zigzag band (*le grain*) of calms which separates the wind from S.W. from the N.W. wind on its front. The phenomena are connected with the "Sturmlinien" of Bezold. The author claims to have followed the advance of such a storm-line from Ireland to St. Petersburg, a distance of

1,500 km., on August 27–28, 1900. He does not quote any data in support of this view, however, and his chief object seems to be to disprove the existence of secondary depressions which Sprung assumed in explanation of the V. H. B.

1257. *Barometric Data for Weather Forecasts.* **J. Bosscha.** (Archives Néerlandaises, 5. pp. 529–541, 1900.)—The question of the reduction of barometric data has been discussed but little since the Vienna Meteorological Congress of 1873. This Congress recommended reductions of all data from stations less than 300 m. above sea-level to sea-level. Although all the stations of the Netherlands belong to that category, Buys Ballot, director of the Meteorological Institute of the country, insisted upon recording deviations from the so-called normal barometric values as derived from the means of observations extending over many years. Accepting Haga's observations at Groeningen for 1897, the author proves that the value of those normals is illusory, because they are deceptive in themselves, and, moreover, referred for different periods to different stations. Thus the Helder normal rests partly on the Helder reductions and partly on calculations made at Carlsruhe, Greenwich, Paris, or Vienna. The result is that the comparative data from the four stations of the Netherlands, at Vlissingen, Helder, Groeningen, Maastricht, may indicate barometric equilibrium over the country when there is none, and *vice versâ.* H. B.

REFERENCES.

1258. *Comparison between the Sun's Light and that of Stars.* **C. Dufour.** (International Physical Congress at Paris, Report, 3. pp. 488–494, 1900.)—The writer relates some experiments made on board lake steamers by noting at what point of the course the light of a gas-lamp on the quay appeared equal to that of a star. A. E.

1259. *Circulatory Movements in the Atmosphere.* (Monthly Weather Rev. 28. pp. 532–535, 1900.)—Mathematical extracts from an article by **V. Bjerknes** in the Meteorolog. Zeitschr., Nov., 1900, referring to his theory [see Abstract No. 1406 (1900)]. H. B.

LIGHT.

1260. *Pressure of Light Rays.* **D. A. Goldhammer.** (Archives Néerlandaises, 5. pp. 467–483, 1900.)—Bartoli found that in total reflexion there is a pressure p on the reflecting surface equal to $2e$, where e is the energy per unit of volume. Boltzmann from thermodynamic considerations found that with a perfect vacuum space enclosed by heat-proof walls with normal incidence, $p = e$, or $p = 2e$ according as the surface is absorbent or perfectly reflecting. According to Maxwell (art. 792), there is a pressure normal to the waves and numerically equal to the energy in unit of volume. This is interpreted by Boltzmann to apply to absorbed waves. For perfect reflexion the pressure should be twice as great.

The present writer says that from Maxwell's theorem we cannot directly infer ponderomotive forces to exist at the interface of two media, but the resultant only of those forces which, according to known formulæ of elasticity, arise from the stresses in the interior of every substance. These resulting forces can be calculated only in the limiting case of normal incidence on a perfectly black body. Also the deductions are not correct unless the ponderomotive forces consist only in Maxwell's pressure, that is, unless the electromagnetic tensions give rise to no forces acting in the body itself.

The writer considers a conducting medium, capable of polarisation, moving with velocities α, β, γ. To this he applies Hertz's formulæ, of which the type is—

$$A\mu\left\{\frac{dL}{dt} + \frac{\partial}{\partial y}(\beta L - \alpha M) - \frac{\partial}{\partial z}(\alpha N - \gamma L) + \alpha\left(\frac{\partial L}{\partial x} + \frac{\partial M}{\partial y} + \frac{\partial N}{\partial z}\right)\right\}$$

$$= \frac{\partial Z}{\partial y} - \frac{\partial Y}{\partial z},$$

coupled with—

$$A\epsilon\left\{\frac{\partial X}{\partial t} + \frac{\partial}{\partial y}(\beta X - \alpha Y) - \frac{\partial}{\partial z}(\alpha Z - \gamma X) + \alpha\left(\frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y} + \frac{\partial Z}{\partial z}\right)\right\}$$

$$= \frac{\partial M}{\partial} - \frac{\partial N}{\partial y} - L\pi A u.$$

Multiplying these equations in order by L, M, N, X, Y, Z, and integrating through the space within a closed surface, he obtains expressions for the ponderomotive forces acting on the bounding surface and in the interior. He then supposes the medium to be initially at rest, and a disturbance to pass through it of the usual form—

$$A\mu\frac{\partial L}{\partial t} = \frac{\partial Z}{\partial y} - \frac{\partial Y}{\partial z} \text{ \&c.}$$

$$A\epsilon\frac{\partial X}{\partial t} = \frac{\partial M}{\partial z} - \frac{\partial N}{\partial y} - L\pi A u, \text{ \&c.}$$

In order, then, to find $\alpha\beta\gamma$, the forces so obtained are treated as external forces acting on an elastic body.

We are concerned, not with the instantaneous values, but with the time averages of the forces here in question. The disturbance is supposed to be periodic, of the form $a\cos\left(b - \frac{2\pi t}{T}\right)$ with period T.

The author then takes the plane $z=0$ for the reflecting surface, and $x=0$ for plane of incidence. And if ϕ be the angle of incidence, e_0 and e_r the energies per unit of volume of the incident and reflected wave respectively, we find that from the incident and reflected light there results a pressure p, in a direction making with the normal an angle $\psi = \tan^{-1}\frac{e_0 - e_r}{e_0 + e_r}\tan\phi$, and whose value is $p = \cos\phi\ \sqrt{e_0^2 + e_r^2 + e_0 e_r \cos 2\phi}$.

If then J_ϕ be the coefficient of reflexion, we have $\tan\psi = \frac{1 - J_\phi}{1 + J_\phi}\tan\phi$,

$$p = e_0\cos\phi\sqrt{1 + J_\phi^2 + 2J_\phi\cos 2\phi},$$

whence— (1) for *perfect reflexion* $\psi = 0, p = 2e_0\cos_\phi$;

(2) for *perfect absorption* $\psi = \phi, p = e_0\cos\phi$;

(3) for *normal incidence* $\psi = 0\ p = e_0(1 + J_0)$.

Of these results (2) agrees with Maxwell, (1) with $\phi = 0$ agrees with Boltzmann.

Next, the author considers the force on the other side of the reflecting surface, and finds in case of complete absorption zero force in the normal, but a force tending to rotate the plane about the normal. For a perfectly transparent medium with normal incidence he finds for the pressure of light on the further side of the surface $p = 2(e_0 - e_d)$, where e_d is the energy per unit of volume in the second medium. And this can be put in the form—

$$p = \frac{e_0 4J_0}{1 + J_0};$$

or if $J_1 = \frac{1}{3}, p = e_0$, as in the case of a black body. In the last section is treated a case of special interest in which the incident light is polarised at right angles to the plane of incidence. If the second medium be a plate movable in the direction of the normal, it is found that there is a force tending to rotate it. S. H. B.

1261. *Reversibility of Radiation.* **J. D. van der Waals, Jr.** (Archives Néerlandaises, 5. pp. 587–594, 1900.)—The author first reviews the Planck-Wien controversy as to whether the free propagation of radiation is a reversible or irreversible phenomenon, the test of the reversibility being the constancy of the entropy. He then introduces two new tests for perfect reversibility other than that of the constancy of entropy. According to these tests the conditions of reversibility are : (1) Is it always in our power to accomplish the action in the reverse sense? (2) Would the reverse action occur accidentally with the same probability as the direct action?

Applying these tests to the radiation problem he concludes—

(1) It is easy to see that an arbitrary reversal of the radiation is scarcely possible. Even if we could use a perfectly reflecting sphere surrounding a small radiating sphere the rays would not all fall normally on the spherical surface, and consequently would not be reflected back along the paths of incidence. The rays from one molecule would not converge after reflection towards the same molecule, but would come to a focus at another point where at that moment possibly no molecule was present. Thus, we could not obtain exactly the same action in the reverse direction.

(2) The energy emitted by a molecule presents a symmetry around that molecule. If, then, one surrounds a radiating sphere by a concave mirror, or by a concave body at the same temperature, there will fall on each molecule on the average the same energy as it radiates, since it maintains a constant temperature; but the symmetry around the molecule is absent from the radiation incident on the molecule. The incident radiation cannot, then, from all points of view be considered as the reverse of the radiation emitted. Thus free propagation of radiation ought rigorously to be considered as irreversible. J. B. H.

1262. *Diffraction of Light of Variable Intensity.* **H. M. Reese.** (Astrophys. Journ. 13. pp. 199–207, April, 1901.)—This investigation was undertaken to determine if any noticeable disturbance of the resolving power of a spectroscope was produced by the absorption of the very dense glasses now in use. After developing the formulæ devised, they are applied to the case of the new Mills spectrograph at the Lick Observatory, the result being that the resolving power of that instrument is not diminished by more than 0·5 per cent. by the absorption of the prisms.

Diagrams are given showing the forms of the lines with and without consideration of the absorption. C. P. B.

1263. *Doppler's Principle.* **W. Michelson.** (Astrophys. Journ. 13. pp. 192–198, April, 1901.)—The author extends the investigation on the variation of the wave frequency with motion either of source or observer, or both, to include cases not considered by the ordinary formulæ in use.

The usual assumptions on which the principle is based are—(1) that the period of vibration of the source is not influenced by its motion along the line of sight; (2) that the medium carrying on the waves is at rest as a whole, and that its properties are not changing.

The present investigation refers more particularly to the second supposition, and formulæ are derived expressing the impressed change of wavelength due to movement of a layer of vapour through which the light has to pass. It is deduced that if a region of *increasing density* be made active, the rays are displaced towards the *red*, while a decrease of density of the transmitting medium causes a shift towards the violet.

This will have a most important bearing on the frequently observed distortions of the spectral lines over the regions of sunspots, prominences or faculæ, as, by this reasoning, velocity in the line of sight may only cause part of the change, and further, a translation of one kind of matter, say hydrogen or iron vapour, may involve distortions of the lines of quite different elements, say those of helium, calcium, &c. C. P. B.

1264. *Influence of the Medium on the Photochemical Effect in Silver Bromide Emulsions and Photochemical Induction.* **R. Abegg** and **C. Immerwahr.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 974–980, 1900.)—The researches of Luggin and of Luther [Abstract No. 1113 (1900)] have shown that the action of light on silver haloid compounds finally results in a state of chemical equilibrium, which is defined by a definite potential (gas-pressure, e.m.f., or solution concentration). This state is, however, never reached in ordinary photographic processes, firstly because the time of exposure is too brief, and secondly because the halogen liberated from the silver salt is removed from the sphere of action either by diffusion or by combination with the gelatine or other medium employed. It is this latter which is probably the cause of the superior sensitiveness of gelatine plates as compared with those made with collodion, a comparatively inert substance. But although the ease with which the gelatine takes up the halogen favours the photochemical effect, the medium also exerts a retarding influence in that it prevents the escape of halogen by diffusion. This may be shown by exposing two similar plates, one with the gelatine, and the other with the glass towards the light. The action is less in the latter than in the former case, the diffusion of the halogen being hindered by the proximity of the glass plate to the sensitive film. N. L.

1265. *Apparatus for Demonstrating the Doppler-Fizeau Principle.* **A. Bélopolsky.** (Astrophys. Journ. 13. pp. 15–24, Jan., 1901.)—The principle of the apparatus was suggested by the author in 1894, and he has recently been enabled to construct it. By means of successive reflections from rapidly revolving mirrors, the wave-length of incident light is altered. The spectrum of solar light was compared with the spectrum of the same light after reflection from the moving mirrors, and the lines were found to be sensibly displaced. A detailed description and results of first experiments are given. A. E.

1266. *Ocular Accommodation.* **M. Tscherning.** (International Physical Congress at Paris, Report, 3. pp. 547–560, 1900.)—An instrument has been used by the author for studying the aberration of the human eye, and has been called by him the aberroscope. It consists of a plano-convex lens, the plane side of which is ruled in millimetre squares; through the lens a distant object is seen as a circle of diffusion, and the shadows of the line are also seen cast upon the retina. In a state of rest most observers see the lines convex inwards, which indicates a certain degree of ordinary aberration. When an effort is made at accommodation this convexity turns outwards.

When accommodation reaches its maximum it has been noticed that the shadows cast by any irregularities which exist in the media of the eye undergo a displacement which seems to indicate a downward displacement of the crystalline lens. This Hers presumed to be the result of gravity acting on the lens when the suspensory ligament is relaxed. This displacement is not noticed when the eye is directed vertically upwards, as when the person is lying on the back. The author has observed the motion of the image reflected from the upper middle and lower portion of the posterior surface of the crystalline lens of the eye with a telescope during accommodation, and found in the first instance a considerable downward displacement of the reflecting surface, in the second case less, while in the third case the displacement was but slight. He concludes that the phenomena can be explained by supposing that during accommodation the contraction of the ciliary muscle exercises a traction on the fibres of the zonule which are inserted into the anterior surface of the lens, while at the same time the fibres which go to the posterior surface are relaxed. W. C. O.

1267. *Coloured Glasses.* **R. Zsigmondy.** (Zeitschr. Instrumentenk. 21. pp. 97–101, April, 1901.)—This paper is an appendix to the article on the absorption of light in coloured glasses [Abstract No. 784 (1901]. Schott & Co., of Jena, have manufactured various coloured glasses for use as light filters for different parts of the spectrum and for three-colour photography.

The author gives a list of fourteen of these glasses and spectrum curves, showing the absorption. They are severally transparent to the following wave-lengths: $\mu = 0{\cdot}59$ and beyond, 0·51 and beyond, 0·53 to 0·59, 0·50 to 0·62, 0·49 to 0·70, 0·52 to 0·60, 0·50 to 0·63, 0·49 to 0·57, 0·50 to 0·56, violet to 0·60, to 0·55, to 0·50, to 0·48, to 0·49 with 0·70 and beyond, violet to 0·44 with 0·67 and beyond, violet to 0·45.

The author also mentions combinations of these which are useful for certain purposes. G. H. B.

1268. *Resolution of Light into its Circular Components in the Faraday Effect* **D. B. Brace.** (Phil. Mag. 1. pp. 464–475, April, 1901. Paper read before the American Physical Society, Oct. 27, 1900.)—Fresnel's interpretation of the rotation of the plane of polarisation—the propagation of the light in the medium as two opposite circularly polarised beams—has been applied to the Faraday effect, but has up till now remained without experimental verification. Indirect evidence by interference methods has tended to confirm the principle without, however, conclusively establishing it.

The author, after several failures, has at last succeeded, by means of refraction, in resolving natural light into its two opposite circular components when propagated along the lines of force. In his successful method he employs two equilateral right-angled prisms of very dense glass and a "half-wave" plate of mica, the two prisms being cemented by their diagonal faces to the mica plate so that the combination forms a square prism with the mica plate along one diagonal. The beam of light is introduced into the prism near one end and almost perpendicular to the prism axis. It is introduced through a small auxiliary 45° prism cemented to one of the faces near the end. After being internally reflected round the prism four or five times, it passes out by a similar auxiliary prism near the other end and continues its former direction. The prism is placed in the magnetic field so that the beam in passing once round the prism moves only along and perpendicular to the lines of force. With a field of 8,700, obtained between pole-pieces 10 cm. square and 11 mm. apart by means of a very large magnet weighing two tons, the author has succeeded in separating the two circularly polarised beams in which the beam is propagated while passing through the prism, the angular separation after passing five times round the prism being 0·005 in absolute angular units. This agrees with the value calculated from Verdet's constant. J. B. H.

1269. *Magneto-optical Phenomena.* **H. A. Lorentz.** (International Physical Congress at Paris, Report, 3. pp. 1–33, 1900.)—The various theories put forward to account for the influence of a magnetic field on the emission of light are explained and discussed. In particular it is shown how, from the consideration of a radiating molecule as a material system of μ degrees of freedom, it follows that, if ν of the corresponding frequencies are equal apart from the magnetic field, there results a spectral ray which splits up into ν components under the action of a magnetic field. The author considers Voigt's method to be the only one which enables us to understand the phenomena depending upon the density of the radiating bodies and the width of the spectral lines; however, he looks for its development by the introduction of notions as to what occurs in the molecule, and a replacement of the hypothesis of a resistance proportional to the velocity by a theory of absorption. Finally, from the direct treatment of the emission of a system of interacting molecules, he looks for the explanation, in the case of dissymmetry discovered by Voigt, of the existence of vibrations slightly different in period, some of which determine the radiation in the direction of the field, and others that in the transverse direction. W. E. T.

1270. *Atmospheric Absorption of Visible Rays.* **A. Cornu.** (Astrophys. Journ. 13. pp. 142–148, March, 1901.)—One of the searchlights at the summit of the Eiffel Tower was directed towards the École Polytechnique (in 1889) for the purpose of determining absorption. The distance is about 4,350 metres. The dark lines in the spectrum of the electric light were examined under high dispersion and compared with the author's maps. "It follows from the spectroscopic observations that more than 200 dark lines, produced by the atmospheric absorption of radiations from a terrestrial source of light, have been identified, one by one, with the so-called *telluric* lines observed in the solar spectrum. The atmospheric origin of these lines is thus verified beyond all question." The author remarks that the observations also constituted a direct and valuable test of the *method of oscillating lines* which had led him to distinguish between solar lines and those of terrestrial origin in the most complicated groups of the solar spectrum. A. E.

1271. *Flash Spectrum, Solar Eclipse May* 28, 1900. **H. C. Lord.** (Astrophys. Journ. 13. pp. 149–166, March, 1901.)—Measures of 229 lines on two photographs of the flash are tabulated and discussed, and the apparatus is briefly described. The general conclusion is that "these lines may be completely explained by a reversal of *some* of the Fraunhofer lines combined with a change in their relative intensities, plus those lines due to helium. That the flash spectrum is the reversal of *all* the Fraunhofer lines is far from being borne out by the plates." Of 1,144 solar lines given by Rowland, 60 per cent. are lacking, including many of the brightest lines, especially those due to iron. A table is given of computed elevations above the sun's limb of the upper limit of substances emitting certain lines. The four lines whose elevation comes out greater than 1,000 miles are F, 4,713·67, 4,471·83, and 5,015·80. The last three agree closely with lines found by Runge and Paschen in the spectrum of Clèveite gas; but the behaviour of 5,015·80 is very peculiar, and resembles that of a line at 4,686·28, both showing much more markedly at the horns of the crescent than at the vertex, a peculiarity shared by no other lines. The author thinks these two lines must be common to some substance. Rydberg deduces from formulæ a hydrogen line at 4.687·88 (Astrophys. Journ. vi. 233). The line 4,686·28 may be this hydrogen line. Its intensity, however, is not a tenth that of $H\beta$ or $H\gamma$. A. E.

1272. *Spectra of Carbon Compounds.* **A. Smithells.** (Phil. Mag. 1. pp. 476–503, April, 1901.)—The hydrocarbon flame spectrum, first mapped by Swan in 1857 and generally known as the "Swan spectrum," has since then been the subject of many investigations; in these the spectrum has been attributed to almost all the constituents of the flame except carbon monoxide. Stokes and Smithells were independently led to the idea that the spectrum might really be due to carbon monoxide, and in the present paper the latter describes experiments which he has made during the last eight years with the view of testing this assumption. The experiments strongly support the idea, and a review of the experimental results of former experimenters shows that many of these also uphold the carbon monoxide assumption, while the others which do not directly support it in no case support the direct negative. The paper contains an epitome of a large number of experiments on the spectra of carbon and its compounds. J. B. H.

1273. *Transparency of Matter for Röntgen Rays.* **L. Benoist.** (Comptes Rendus, 132. pp. 545–548, March 4, 1901.)—The laws, enunciated in a previous paper [see Abstract No. 1074 (1901)], which govern the transmission of Röntgen radiation through matter in various forms are dealt with in further detail on various points. Curves are given showing clearly how the transparency depends on the atomic weight for a large number of elements. Previous work on the same subject is criticised, especially with the view of showing that the relative transparency of bodies for Röntgen rays depends very largely on the quality of the radiation, and that in previous experiments this has not been sufficiently taken into account. It is proposed that this property be made use of as a means for comparing the hardness or softness of the rays. R. S. W.

1274. *Determination of Atomic Weights by Röntgen Rays.* **L. Benoist.** (Comptes Rendus, 132. pp. 772–774, March 25, 1901.)—An interesting and ingenious application of the laws discovered by the author, relating to the transparency of matter to Röntgen rays. [See preceding Abstract and No. 1074 (1901).] It is shown that the atomic weight of an element can be inferred from measurements of its transparency and of that of other elements whose atomic weight is known. These measurements may be carried out either on the element in the pure state or on a mixture or compound of it with others. The method is therefore more general than the one founded on the specific heat law of Dulong and Petit, as the transparency does not depend on the physical state. An application is made to the determination of the atomic weight of indium, chemists having to choose between two possible values, viz., 75·6 and 113·4. The transparency equivalent of the element was deduced from measurements of that of acetylacetonate of indium as well as from observations on the metal itself. Comparing the value so obtained with the values for arsenic and silver by means of his published curves, the author finds 113·4 as the atomic weight, to the exclusion of the smaller value. R. S. W.

1275. *Absorption of Röntgen Rays.* **A. Hébert** and **G. Reynaud.** (Comptes Rendus, 132. pp. 408–409, Feb. 18, 1901.)—A kind of modified Duboscq colorimeter is used, the tubes ending in cardboard covered with guttapercha. The absorptions of saline solutions are compared with that of a column of water 41·5 mm. long. The general result, using nitrates of NH_4, Ba, Cd, Ca, Co, Cu, Li, Mg, Mn, Ni, K, Na, Sr, and Zn, is that the absorption is proportional to the atomic weight of the metal in the salt. The absorption of different acids combined with the same metal seems also to increase with the molecular weight of the acids. In a compound, that element which has the greatest atomic weight has the greatest effect on the absorbing properties of the substance. G. E. A.

1276. *Propagation of Röntgen Rays.* **G. Sagnac.** (Annal. Chim. Phys. 22. pp. 394–432, March, 1901.)—The absence of interference or diffraction fringes is not conclusive proof of rectilinear propagation, the radiations being widely heterogeneous : the spreading of a pencil of rays by diffraction is always related to the wave-length, and with Röntgen rays it is so slight as to show that the wave-length is at any rate 28 times smaller than that of ray D. This result was obtained by the author with the original tubes; since then, focus tubes have shown (Gouy, Haga and Wind) that the wave-length would be 2,000 times less than that of the green, for those rays which have traversed glass, air, and thin wood or black paper. Refraction, dichroism, double dichroism, all give negative results, more or less obscure where the crystals used are themselves dichroic. The absorption of Röntgen rays appears independent of the crystalline structure of the substance, and presents a character chiefly atomic. The author discusses various illusions presented by Röntgen rays, leading apparently to a distinction between Röntgen rays and light; but these find their parallel in the behaviour of ordinary penumbræ from sources of some size and of particular forms. Röntgen rays travel in straight lines, subject to scattering which bears no relation to the diffusion or reflexion of light on the surface of the body traversed. Apparent maxima and minima of Röntgen illumination through slits or past obstacles are closely analogous to similar peculiarities in ordinary light and are not due to diffraction, but may be traced to peculiarities of the photographic plate and of the retina of the eye. On the photographic plate and the retina the impression is greatest or least where the curve showing the true variation of illumination presents a sharp bend or where its tangent is steep. The cause of this lies in the influence of neighbouring parts of the sensitive film or of the retina, this influence being that of a secondary destructive or reversing action, possibly due to secondary rays excited by the impinging Röntgen rays. In the case of the plate this action may tell upon the formation of the latent image, or possibly upon the process of development: more probably the former, for, if so, this would go far towards pointing out an explanation of ordinary reversal under over-exposure, with its waning maxima and minima, and ultimate neutral state. This would follow from (1) a positive action proportional to the time, and (2) a negative action, the change of which is proportional to the resultant effect at a given interval of time prior to the instant of observation. The apparent peculiarities in the rectilinear propagation of Röntgen rays all disappear: the course of Röntgen rays is the same as that of light rays. At the same time we have no diffraction, refaction, reflexion, or regular polarisation. All this is, however, brought into harmony by the Stokes and J. J. Thomson theory, with the additional observation that with ordinary light refraction would be impossible if the wave-lengths were less than twice the distance between the particles of the prism. It is also impossible where the train of disturbance of the ether produced by molecule-impacts (Stokes) dies out in less than twice the same distance; and the result is the same whether for transverse or longitudinal ether disturbance (see the author, Journ. de Physique, 3. ser. t. ix., p. 188, 1900). The same short wave-lengths or disturbance trains also necessarily act in an ordinary pure homogeneous medium as ordinary light does in a troubled medium; which explains the scattering of Röntgen rays. A. D.

1277. *Effect of Becquerel and Röntgen Rays on the Eye.* **F. Himstedt** and **W. A. Nagel.** (Ann. d. Physik, 4. 3. pp. 537–552, March, 1901. Aus den Ber. d. Naturf. Gesellsch. in Freiburg i. B. XI. p. 139, 1901.)—Becquerel rays excite fluorescence in all parts of the eye. Consequently when the rays pass through different shaped openings in a lead plate, the eye is unable to distinguish the different shapes of these openings. When using ultra-violet rays the authors could not succeed in entirely freeing these from visible rays, and were forced to conclude that ultra-violet rays also produce fluorescence in the eye. Under Röntgen rays no fluorescence could be observed in the different parts of the eye, and it is doubtful if the retina fluoresces to any perceptible extent. It may be said, however, that perception of Röntgen, Becquerel and ultra-violet radiation is chiefly, if not entirely, by means of the rods of the retina, but whether by direct action or indirectly by fluorescence could not be decided.

A purely objective proof of the action of Röntgen rays on the eye was demonstrated by using the current from a frog's eye. The back and front of the eyeball of a frog, which had been kept in the dark, are connected by unpolarisable electrodes with the galvanometer circuit of a potentiometer; a current flows along the circuit from the front to the back of the eye with an e.m.f. of from 0·0056 to 0·0172 volt. When light or Röntgen rays fall on the eye the e.m.f. increases for from 10 to 60 seconds and then decreases. On stopping the action of the light or Röntgen rays there is a momentary increase followed by a quick decrease of the e.m.f. For eight frog's eyes tested the increase in e.m.f. caused by 30 seconds' exposure to Röntgen rays was, on the average, one-third of that caused by 10 seconds' exposure to a 16-c.p. glow-lamp. For the eight eyes the e.m.f. increase due to the glow-lamp had respective values varying from 0·00085 volt to 0·0022 volt.

G. E. A.

1278. *Secondary Radio-Activity.* **H. Becquerel.** (Comptes Rendus, 132. pp. 734–739, March 25, 1901.)—The author has carried out further researches on the secondary rays produced by the impact of radium rays. [See Abstract No. 1077 (1901).] He finds that the glass supporting the gelatine films plays an important part in the phenomena described. He proceeds to explain certain peculiarities shown by radiograms on the basis of the secondary rays.

E. E. F.

1279. *Secondary Rays Derived from Röntgen Rays.* **G. Sagnac.** (Annal. Chim. Phys. 22. pp. 493–563, April, 1901.)—A summary of extant knowledge, with some additional researches. When Röntgen rays are sent through any substance that substance emits secondary rays in every direction from every particle within a certain depth. These secondary rays resemble Röntgen rays in (1) rectilinear propagation, (2) production in a similar way of tertiary rays, (3) action upon photographic plates, (4) illumination of barium platinocyanide screens, (5) discharge of electrified conductors. The penetrating powers of the secondary rays vary with (1) the nature of the impinging Röntgen rays, (2) the chemical constitution, but not appreciably the physical condition of the substance from which they are developed. In heavy metals (Cu, Zn, Fe, Ni, Sn, Pt, Pb) or substances containing these, the secondary rays are less penetrating than the originating Röntgen rays and can only emerge from layers very near a free surface, particularly the surface of impact or of exit, of the Röntgen rays. The phenomenon is thus not one of selective diffusion; there is a true transformation into less penetrating rays. The tertiary rays are still less penetrating than the secondary. The bundles of Röntgen rays hitherto employed act as mixtures of radiations differing greatly in penetrative power; and secondary rays, even when produced by simple substances, are extremely complex, particularly when heavy metals or their compounds are used. In the order in which the above metals have been named, the later in the series the greater the transformation in the production of secondary rays, and the more absorbable and the more active the secondary rays produced under the impact of Röntgen rays from one and the same source; and in all secondary rays the more active these are the more easily are they absorbed. For Fe, Ni, Sn, Pt, Pb, the most active (electricity-discharging or radiographic) secondary rays are absorbed by layers of air down to 1 cm., 1 mm., or even less, while the Röntgen rays which give rise to these will traverse much greater thicknesses of air. A. D.

REFERENCES.

1280. *Retinal Phenomena.* **A. Charpentier.** (International Physical Congress at Paris, Report, 3. pp. 523–546, 1900.)—The author deals with the following questions: (1) What are the objective phenomena produced by light upon the retina? (2) What are the subjective phenomena, or sensations produced by light as it varies in intensity, colour, form, position or duration? (3) If, as is often the case, the two preceding questions cannot be investigated upon the same subjects (man alone being available for the second), is it possible to establish their similarity? The article is a *résumé* of the work done by various physicists and physiologists of modern years who have studied this department of science. W. C. O.

1281. *Representation of Substances which Rotate the Plane of Polarisation.* **A. Garbasso.** (Archives Néerlandaises, 5. pp. 524–528, 1900.)—From the suggestion of Bose's experiments on the passage of electric waves through a rope of jute fibres, the author constructs a set of electromagnetic equations representing those optical media which rotate the plane of polarisation. The results obtained are in accord with Lorentz's equations. E. H. B.

1282. *Dispersion of Ultra-violet Rays in Rock-Salt and Sylvin.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 3. 4. pp. 31–35, 1901.)—The refractive indices of prisms of rock-salt and sylvin are measured for a number of ultra-violet spectral lines in the spark spectra of Al, Au, Cd, Pb; and for a number of lines in the visible spectra of H, Hg, K, Li, and Na. The results are tabulated in the paper, the refractive indices being given for forty-one different wave-lengths between the values 185 and 769 $\mu\mu$, twenty-five being in the ultra-violet and sixteen in the visible spectrum. J. B. H.

1283. *A Simple Spectrometer and the Measurement of Refractive Indices.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 3. 2. pp. 10–17, 1901.)—The various ways of using a spectrometer to measure the angles and refractive indices of prisms are here reviewed and compared as to their applicability and accuracy in different circumstances. J. B. H.

1284. *Distribution of Energy in the Spectrum.* **M. Planck.** (Ann. d. Physik, 4. 3. pp. 553–563, March, 1901.)—The author presents the arguments and conclusions of two previous papers in a different form and in fuller detail. [See Abstracts Nos. 507 and 508 (1901).] W. E. T.

1285. *Spectra of Coloured Glasses.* **C. Grebe.** (Zeitschr. Instrumentenk. 21. pp. 101–105, April, 1901.)—This paper contains spectrum photographs on Cadett spectrum plates taken through the coloured glasses mentioned in Abstract No. 1267 (1901). Thirty-five photographs are reproduced for the different glasses in different thicknesses, and for combinations suitable for three-colour photography and other purposes. G. H. B.

HEAT.

1286. *Latent Heat of Evaporation of Liquids.* **H. Crompton.** (Chem. Soc., Proc. 17. pp. 61–63, April 10, 1901.)—On the assumption that it would be possible at constant temperature and by compression alone to reduce a saturated vapour from the volume V_0 to the volume v_0 which the liquid it forms would normally occupy, without any change in state occurring, and with the substance continuing to obey the gas law, the author deduces the expression $2RT \log V_0/v_0$ for the latent heat of evaporation. By means of the observations of Cailletet and Mathias on carbon dioxide, nitrous oxide, and sulphur dioxide he is able to test the formula for fairly wide variations of temperature and pressure with satisfactory results. In general the calculated values are from 5 to 10 per cent. too high, perhaps because the saturated vapour at the boiling-point is not a perfect gas, and has a slightly higher density than that corresponding to the normal molecular weight. With a few associating liquids the calculated values are slightly too low. The author points out that if liquids were truly comparable at the boiling-point, the ratio V_0/v_0 would be the same for all liquids at this point, and then Trouton's law, according to the above expression, would hold absolutely.
W. E. T.

1287. *Tempering of Thermometers.* **O. Hecker.** (Zeitschr. Instrumentenk., Beib. 5. pp. 41–42, March 1, 1901.)—A convenient method of tempering thermometers, in order to prevent error due to change in the fixed points, is described, and its advantages pointed out. The thermometer is contained in a vessel round which a coil of platinum wire is wound, which can be maintained at a high temperature by means of an electric current. By means of clockwork a resistance is gradually inserted so that the temperature gradually falls and a slow cooling of the thermometer ensues. Details are given of the apparatus used by the author. W. E. T.

1288. *Boiling-point of Liquid Hydrogen.* **J. Dewar.** (Roy. Soc., Proc. 68. pp. 44–54, March 5, 1901.)—A platinum-resistance thermometer had given the value —238·4° C., but as this depended on an empirical ratio between temperature and resistance, and involved a large interpolation, it became necessary to have recourse to the gas thermometer. The constant-volume form was found most suitable, using Chappuis's formula; the apparatus is figured and described. The gases used were O_2 helium, CO_2, and H_2, electrolytic and from palladium. It was proved that either a simple or compound gas, at an initial pressure somewhat less that 1 atmosphere, could be relied on to determine temperatures down to its own boiling-point, and that the initial pressure should be rather high than low. Helium had the advantage of being less condensible than hydrogen. It was obtained from the King's Well at Bath, and when purified was free from other gas except 7·4 per cent. of neon, according to refractivity measurements. Tables are given of the various determinations and of the corrections. The average values found for the boiling-points were: CO_2 — 78·2°; O_2 — 182·5°; H_2 — 252·5°; neon — 239°; air 189·6°; solid hydrogen (from palladium, 30 to 40 mm.) 257·2°. S. R.

1289. *Calibration of Thermo-electric Elements.* **E. L. Nichols.** (Archives Néerlandaises, 5. pp. 339–347, 1900.)—A description is given of a quick method of calibrating elements formed of platinum and platinum alloys. This calibration is needed as the value of the e.m.f. found in particular cases depends on the special specimens of metal used. The melting-points of certain metals are known and are used as reference points. The author uses a specially arranged acetylene flame, in which a very constant and high temperature can be obtained at definite points by suitable adjustments. In this flame the various metals with reference melting-points are fused. By means of this arrangement the use of an air thermometer is avoided, and the long and laborious procedure of fusing metals in considerable masses within a furnace is not necessary; and, moreover, the mass of metal required is very much smaller, and the action on the junction caused by fumes is avoided. The accuracy of the method described is claimed by the writer of the paper to be equal to that of other known methods of calibration. J. J. S.

1290. *Temperature of Highly Heated Bodies by Photometric and Bolometric Methods.* **O. Lummer** and **E. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 3. 4. pp. 36–46, 1901.)—The authors have in a former paper described their experiments, comparing the radiation of the ideal black body with that of a polished platinum surface by means of a spectrobolometer. These experiments proved that the equation $\lambda_m T =$ const. holds for the platinum surface as well as for the black body, the constant, however, being 2,630 for the platinum surface, and 2,940 for the black body. If we know λ_m for any other radiating body, the above equation enables us to fix its temperature at least between certain limits, the temperatures of the platinum surface and of the black body which correspond to the given value of λ_m. The limits thus obtained are wide, being about 200° C. at about 2,000° C. To reduce those limits one would require to know the relative blackness of the radiating body, but in many cases they can be reduced by a purely photometric method. Wanner used this method to determine the temperature of the electric arc. He obtained the isochromatic energy-temperature curves for the visible spectrum and extrapolated them, assuming Wien's formula to hold. This assumption was justified by Paschen's spectro-bolometric experiments, but the later experiments by the present authors have shown that Planck's formula satisfies the conditions much better—

$$E = \frac{C\lambda^{-5}}{e^{\frac{c}{\lambda T}} - 1}$$

This formula is not (like Wien's) applicable only within certain limits; it is deduced from the Boltzmann-Wien law,

$$E = T^5 \phi (\lambda T),$$

which has been established both theoretically and experimentally (Wien's formula holds only if $\lambda T < 3{,}000$).

The authors have photometrically determined the isochromatic curves in the visible spectrum of their electrically incandesced "*black body.*" These curves give the mean value of c in the above equation as 14,580, while the value obtained from the spectro-bolometric experiments was 14,600. Wien's equation would give $c = 14{,}700$, so that there is little difference between the two equations when $\lambda T < 3{,}000$, which is the case for the visible spectrum at all earthly temperatures.

Similar curves are also determined for an incandescent platinum cylinder having a thermoelectric junction inside to measure the temperature. A comparison is thus obtained between the visible radiation of incandescent platinum and that of the ideal black body. The difference of temperature between the two for equal radiation is about 40° at 1,100° C. and about 110° at 1,876° C. The error in assuming the radiation of any other body (say an incandescent lamp) to be that of the ideal black body and calculating its temperature accordingly, would be less than in the case of incandescent platinum ; and if the mean of the temperatures obtained photometrically and bolometrically be taken, a still closer approximation to the real temperature can be obtained. [See further Abstract No. 1045 (1900).] J. B. H.

1291. *Molecular Attraction in Slightly Compressed Gases.* **M. Reinganum.** (Archives Néerlandaises, 5. pp. 574–582, 1900.)—On van der Waals' theory the forces between the molecules in the interior of a gas compensate each other, but this is not likely for small densities, and, taking into account the planetary influence of the molecules on each other, the author has found that, if $\chi(\sigma)$ denotes the maximum work done by the attractive forces during the approach of two molecules, the usual expression, $\frac{1}{3}\pi n\sigma^3u^2/v$, for the virial of the repulsive forces exerted during an encounter, assumed as instantaneous, should be altered in the ratio $exp\ (3\chi/mu^2)$ or $exp\ (c/\mathrm{T})$, where c is a constant proportional to χ and independent of the absolute temperature T, but like χ decreasing with v. The author now gives reasons for assuming that the virial of the attractive forces is $-\frac{3}{2}\mathrm{U}$, where U denotes the heat required to expand unit mass isothermally from v to infinity : hence Clausius' virial-equation becomes—

$$\tfrac{1}{2}u^2 = \tfrac{3}{2}pv + \tfrac{3}{2}\mathrm{U} - \tfrac{1}{3}\pi n\sigma^3u^2v^{-1}e^{c/\mathrm{T}},$$

whence, if, as usual, $b \equiv \frac{2}{3}\pi n\sigma^3$, $\mathrm{RT} \equiv \frac{1}{3}u^2$,

$$pv + \mathrm{U} = \mathrm{RT}(1 + bv^{-1}e^{c/\mathrm{T}}).$$

The reasoning by which the above value of the virial of the attractive forces is obtained shows these forces to be inversely as the fourth power of the distance, and gives—

$$\mathrm{U} = \mathrm{R}bcv^{-1}\left\{\log(c/\mathrm{T}) + c/\mathrm{T} + (c/\mathrm{T})^2/1.2^2 + (c/\mathrm{T})^3/1.2.3^2 + \ldots\right\},$$

and for the internal pressure, $p_i \equiv \mathrm{U}/v$, we have—

$$\partial p_i/\partial \mathrm{T} = -\mathrm{R}bce^{c/\mathrm{T}}/\mathrm{T}v^2.$$

R. E. B.

1292. *Reduced Gibbs' Surface.* **H. Kamerlingh Onnes.** (Archives Néerlandaises, 5. pp. 665–678, 1900.)—Reckoning the energy and entropy of a fluid by their variations ϵ,η from their values at the critical point, given by P, V, T, and considering a fluid whose changes of pressure and temperature are proportional when isometric, so that with "reduced" co-ordinates

$$\pi = \mathfrak{A}\tau + \mathfrak{B},$$

where $\mathfrak{A}$ and $\mathfrak{B}$ are functions of the reduced volume ω, and taking the isometric specific heat k to be constant, we have (with slightly simplified notation)—

$$\mathrm{E} \equiv \epsilon/\mathrm{PV} = -\int_1^\omega \mathfrak{B}\,d\omega + \mathrm{S}(\tau - 1),$$

$$\mathrm{H} = \eta\mathrm{T}/\mathrm{PV} = \int_1^\omega \mathfrak{A}\,d\omega + \mathrm{S}\log\tau,$$

where

$$\mathrm{S} \equiv \kappa\mathrm{T}/\mathrm{PV} = \mathrm{RT}/\mathrm{PV}(\kappa - 1),$$

whence on the thermodynamic surface with ω, E, H for co-ordinate axes the *shape* of all the isothermals is the same, being that of the curve given by—

$$E_1 = -\int_1^\omega \mathfrak{B}\,d\omega, \quad H_1 = \int_1^\omega \mathfrak{Z}\,d\omega,$$

and their respective *positions* are obtained by sliding this curve parallel to itself along the director-curve

$$E_2 = S(\tau - 1), \quad H_2 = S \log \tau.$$

On van der Waals' theory $\mathfrak{Z} \equiv 8/(3\omega - 1)$, $\mathfrak{B} \equiv -3/\omega^2$, $S = 8/3(\kappa - 1)$; the author has constructed three models of the surface for this case corresponding to values of κ equal to 1·66, 1·20, 1·06, on which he has traced the connode or so-called "boundary-curve" and the isothermals for $\tau = 1, 0{\cdot}9, 0{\cdot}8, 0{\cdot}5$. These models exhibit the law of the straight diameter to quite low temperatures, and also a parabolic relation between the saturation vapour densities and τ, as well as van der Waals' empirical relation,

$$\log \pi = 3{\cdot}4(1 - \tau^{-1}),$$

for saturation pressures.

Consideration of the projections of the connodes on the ωH- and EH-co-ordinate planes shows that for $\kappa < 1{\cdot}195$ the specific heat of a saturated vapour is never positive, that for $\kappa = 1{\cdot}195$ it is approximately 0 for values of τ between about 0·87 and 0·57, that when $\kappa < 1{\cdot}195$ it has two points of inversion until some value of κ greater than 1·06 below which there is one point of inversion only.

If π is not of the above assumed form, this method can still be employed with due *correction* of the E_1H_1- and E_2H_2- curves, since the assumption holds good as a first approximation. R. E. B.

1293. *Derivatives of the Thermodynamic Potential according to* T *and* p *in the case of Compound Substances.* **J. J. van Laar.** (Archives Néerlandaises, 5. pp. 484–496, 1900.)—The thermodynamic potential of Gibbs and Dickens being denoted by Z, Planck's heat function, Ψ, is—

$$-Z/T = S - \frac{1}{T}(E + pV),$$

in the usual notation. We have also—

$$dE = T\,dS - p\,dV - \Sigma(\mu_1, dn_1).$$

Here μ_1 μ_2, &c., are the so-called molecular thermodynamic potentials of the components, the numbers of the molecules being n_1, n_2, &c.; writing ψ_1, ψ_2, &c., for $-\mu_1/T_1 - \mu_2/T$, &c., we have—

$$\psi_1 = \frac{\partial\Psi}{\partial n_1}, \quad \psi_2 = \frac{\partial\Psi}{\partial n_2}, \text{\&c.}, \quad \frac{\partial\Psi}{\partial T} = \frac{1}{T^2}(E + pV), \quad \frac{\partial\Psi}{\partial p} = -\frac{V}{T}.$$

These relations are discussed in the present paper.

A solution of salt in water is considered. In electrolysis there will be dissociation, some of the water molecules becoming single instead of double. The molecules of the salt are said to be dissociated electrically, the undissociated molecules being neutral, the others resolved into positive and negative ions. The *degrees of dissociation*, that is the proportion of the molecules of a given class which are dissociated, are for the salt a, and for the water β, so that water consists of $(1 - \beta)n_1$ double molecules, $2\beta n_1$ single, and the salt now consists of $(1-\alpha)n_2$ neutral molecules, and of $\nu\alpha n_2$ positive and the same number of negative ions. Here ν is the number of ions into which a neutral salt molecule is resolved. If now we use the symbol d to denote total differentiation, instead of $\frac{\partial\Psi}{\partial n_1}=\psi_1$, &c., we have—

$$\frac{d\Psi}{dn_1}=\frac{\partial\Psi}{\partial n_1}+\frac{\partial\Psi}{\partial\alpha}\frac{d\alpha}{dn_1}+\ldots=\psi_1,\text{ \&c.}$$

The author obtains as the general equations expressing the changes due to any reaction, in which $\Sigma(\nu_1\psi_1)=0$

$$\Sigma\left(\nu_1\frac{d\psi_1}{dT}\right)=\frac{1}{T^2}(\Delta E+p\Delta V),$$

$$\Sigma\left(\nu_1\frac{d\psi_1}{dp}\right)=-\frac{\Delta V}{T},$$

and $\Delta E+p\Delta V$, or Q, is the absorbed molecular heat. These relations were first given by the author in 1892 for a less general case. The distinctive character of the present paper is the use of the total differentiation.

The author next discusses equlibrium of dissociation. If $\overset{\circ}{\psi}_1$, $\overset{\circ}{\psi}_2$, &c., relate to the undissociated parts of the compound substances, so that—

$$\psi_1=\overset{\circ}{\psi}_1+\alpha\,(-\overset{\circ}{\psi}_1+\overset{+}{\nu}\overset{+}{\psi}_1+\overset{-}{\nu}\overset{-}{\psi}).$$

When there is equilibrium, the factor within the bracket is zero, and $\psi_1=\overset{\circ}{\psi}_1$, and this relation continues in the total differentiation according to T and p, and now the equations used are—

$$\Sigma(\nu_1\overset{\circ}{\psi}_1)=0$$

and—
$$\Sigma\left(\nu_1\frac{d\overset{\circ}{\psi}_1}{dt}\right)=\frac{Q}{T^2},\quad\Sigma\left(\nu_1\frac{d\overset{\circ}{\psi}_1}{dp}\right)=-\frac{\Delta V}{T}.$$

Next, if $\overset{\circ}{\psi}_1=\overset{\circ}{\psi}{}'_1-R\log c_1$, &c., we find instead of $\Sigma(\nu_1\overset{\circ}{\psi}_1)=0$,

$$\Sigma(\nu_1\overset{\circ}{\psi}{}'_1)-R\Sigma(\nu\log\overset{\circ}{c}_1).$$

Hence known relations can be deduced. He points out an error frequently made in using ψ' and ψ'_0 in these formulæ.

In the last section he shows how these relations may be applied to the solution of problems, for instance, in electrolysis, the relation between the heat of solution and solubility. S. H. B.

1294. *Van der Waals' ψ Surface.* **C. M. A. Hartman.** (Archives Néerlandaises, 5. pp. 636–641, 1900.)—The author applies the graphical method of K. Onnes (Zittingsversl. Kon. Akad. v. Wet. te Amsterdam, June, 1900, p. 199) to the condensation phenomena, which he has observed in his investigation of the form of the connodal curves for mixtures of methyl chloride and carbonic acid at 9·5° C. He wished to use the same equation and constants as those used for the representation of Kuenen's experiments on mixtures of these substances at 100° C., but in order to obtain from them satisfactory values of the vapour pressures of the pure substances he used the expression—

$$a_x = \frac{K_x}{T_{\kappa x}} e^{\frac{T_{\kappa x} - T}{T_{\kappa x}}}$$

for the molecular attraction, K_x being the function used for the experiments at 100° C.; at the critical temperature $T_{\kappa x}$ of the mixture the equations become identical. The values of the constants used and the results obtained are given for five mixtures, along with a picture of a model of the surface.
W. E. T.

REFERENCES.

1295. *Kinetic Theory of Gases.* **S. H. Burbury.** (Ann. d. Physik, 4. 3. pp. 646–647, March, 1901.)—A mathematical reply to the criticism of G. Zemplén [Abstract No. 828 (1901)] in which the author maintains his own position. E. H. B.

1296. *Measurements of Temperature.* **P. Chappuis.** (International Physical Congress at Paris, Report, 1. pp. 131–147, 1900.)—In this report a brief summary is given of the systematic researches which have been undertaken in order to reduce to one well-defined scale the various arbitrary measurements of temperature. J. J. S.

1297. *Mechanical Equivalent of Heat.* **J. S. Ames.** (International Physical Congress at Paris, Report, 1. pp. 178–213; **E. H. Griffiths,** pp. 214–228, 1900.)—A valuable historical summary is given of the methods employed and the results obtained in the various determinations of the mechanical equivalent of heat. An appendix to the report is written by E. H. Griffiths in which he gives an account of his own work and that of Rowland and Barnes on the *specific heat of water.*
J. J. S.

SOUND.

1298. *Resonance of Air Columns.* **V. Mahillon.** (Phys. Rev. 12. pp. 193–219, April, 1901.)—Air columns of conical, trunco-conical, and cylindrical forms were experimented with in the form of open and partially closed pipes.

The open pipes were made to sound by blowing transversely across the end.

A series of tubes were constructed varying in diameter from 0 to 30 mm. at one end, and having a common diameter of 15 mm. at the other. Each tube had a length of about 24 cm. The following facts were observed: (1) The pitch is the same whether the blast be directed across the large or the small end. (2) The length of the tube is in each case that of a single wave less ¾ of the mean diameter of the tube. (3) The harmonies are proportional to the fundamental sound of the tube.

The tube having diameter 0 at one end and 15 at the other, strangely enough acts as an open pipe, contrary to theory, its length for a given sound being equal to the single wave-length of that sound; and it gives the series of harmonies 1, 2, 3, 4, just like an open pipe. With partially closed pipes the tone is lowered by the closing, the influence which the closing exerts being inversely proportional to the length of the pipe.

In the transverse flute, where the air is made to vibrate by blowing through a hole in the side of the instrument, the length of the tube beyond the hole towards the closed end does not affect the fundamental tone, but does affect the harmonies; hence the length of this part of the flute should never be altered in tuning it, as it acts upon the harmonies which bear a correct ratio to the fundamental tone and throws them out.

In the closed columns formed from the series of cylindrical pipes described above, various methods of producing vibrations were adopted: (A) Directing a blast of air across the open end. (B) Fitting a mouthpiece. (C) By a reed.

The tubes with a small opening at the smaller end, or no opening at all, when caused to vibrate by blowing across the larger end, give, as explained above, the same note as if they were open tubes of the same mean diameter.

The trunco-conical tubes vary in the fundamental note which they give according to the end from which they are blown, but the harmonics remain the same. Trunco-conical tubes seem to act like conical tubes more or less, but their pitch becomes lower as compared with the open tube in proportion to the diameter of the truncated part, where the tube is closed. The diameter of the open end must be at least four times that of the closed end for a tube of trunco-conical form to sound the octave. The fact that the cylindrical tube drops a full octave by stopping one end leaves one to suppose that the phenomenon of the trunco-conical and conical tubes of certain forms resounding like open tubes is due to the reflection of the vibration from the side.

In mouthpiece instruments with cylindrical tubes the air vibrates as in stopped pipe, giving only the odd harmonies. If the lower part of the tube be expanded the fundamental tone rises, as do also the harmonies, approaching gradually the series 1, 2, 3, 4. If the vibration is produced in a reed-pipe by means of a piece of natural reed the flexibility of it is so great that it can set in vibration very different columns of air; the metallic reed requires the column to be almost in unison with it. W. C. O.

1299. *Velocity of Propagation of Sound.* **J. Violle.** (International Physical Congress at Paris, Report, 1. pp. 228–246. Appendix by **M. Brillouin,** pp. 246–250, 1900.)—The different methods adopted to determine experimentally the velocity of sound are discussed, and the values obtained, including that found by the author of the report, are given. The author concludes that the normal velocity in dry air at zero differs very little indeed from 33,136 cm. per second.

The appendix to the report gives a mathematical investigation of the theory of the propagation of sound in a large tube. J. J. S.

1300. *Nature of Vowels.* **E. W. Scripture.** (Amer. Journ. Sci. 11. pp. 302–309, April, 1901.)—The speech curves are obtained by slowly rotating a gramophone plate (one revolution in five hours) and causing a needle to follow the written record, its movements being magnified by means of levers, and finally recorded on smoked paper.

Figures are given showing the form of the vibration for the different vowel sounds. The curve for the vowel "I" shows a series of groups of vibrations similar in form, each group having the form characteristic of a vibration initiated by a blow and dying away by friction. These groups show increasing amplitude, and occur with steadily decreasing intervals. The vibrations evidently result from a series of blows with increasing strength at steadily decreasing intervals.

The fundamental tone of the cord shows as a series of impulses rising from frequency 59 per second to 192 per second; resonance tones, 294, 769, and higher tones are also present.

The combined rise in pitch and amplitude found in "A" is seen also in all curves of "I" which have been examined at the early part of the sound. In the case of "I," however, the vibration changes at the end, showing two vibrations, one slightly stronger than the other, of frequency 192 each, finally lengthening to 82 each.

In the "E" sound, as pronounced in "said," the pitch of the cord tone is nearly constant at 139.

The following conclusions are drawn from a study of the curves.

1. The movement of the air in the mouth cavity is a free vibration and not a forced one, for the mouth tone, as shown by the curve, is constant even while the cord tone is changing; there is therefore no relation between the adjustment of the size of the mouth cavity and the tension of the vocal cords. The mouth tone is not a harmonic of the cord tone.

2. The cord movements, in the formation of the vowel sounds, are of the nature of explosive openings, and not vibratory, as in most musical instruments; hence the impossibility which has been found of producing vowel sounds by the combination of simple tones.

Examination of the anatomical structure of the cords also bears out this theory. They are evidently much more suited for the emission of a series of puffs than to vibrate as stretched membranes. W. C. O.

1301. *Production of Vowel Sounds.* **R. Marage.** (Soc. Franç. Phys., Séances, 2. pp. 109–147, 1900.)—The author gives further analyses of vowel sounds [see Abstract No. 1450 (1900)] by various graphic methods. He also takes moulds of the human vocal organs as posed for the production of various vowels, and reproduces the various vowel sounds with their aid.

E. E. F.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1302. *Distribution of Electricity on an Ellipsoid.* **H. Dörrie.** (Ann. d. Physik, 4. 3. pp. 638–641, March, 1901.)—A mathematical article showing that, if a sphere with uniform distribution of electricity be deformed into an ellipsoid, each element of surface retaining its charge without increase or diminution during the deformation, the resulting distribution of electricity is that which is in equilibrium. The ellipsoidal distribution may be expressed quantitatively as follows: Let O be any point on an ellipsoid of semi-axes a, b, and c charged with M units of electricity, and let p denote the perpendicular from the centre of the ellipsoid to the tangent plane at O, then the surface density at O has the value $Mp/4\pi abc$. E. H. B.

1303. *Fundamental Equations of Electrodynamics and Crémieu's Experiment.* **H. C. Pocklington.** (Phil. Mag. 1. pp. 325–330, March, 1901.)—The equations of the electromagnetic field are deduced in the Hertz form from the results of experiments combined with four assumptions, and are then used to show that a moving charge produces a magnetic field, the argument failing in the case of the charge being on an infinitely long body. The equation in the case of Crémieu's experiment, to produce an induced current in a coil round a rotating disc by suddenly charging the disc, cannot be integrated out, and the author does not consider the hitherto accepted equations of the magnetic field as affected by Crémieu's experiment. G. E. A.

1304. *Long-distance Telephone Lines.* **E. F. Roeber.** (Elect. World and Engineer, 37. pp. 440–441, March 16; 477–479, March 23; and 510–513, March 30, 1901.)—The chief object of this set of articles is to develop the mathematical theory of the Thompson system and the Reed system of line construction for long-distance telegraphy and telephony by methods similar to those adopted by Pupin for his own system [see Abstract No. 2122 (1900)]. M. I. Pupin's system has inductances equally spaced along the line as suggested by Heaviside. The system due to S. P. Thompson is characterised by the insertion of bridges or shunts of appropriate resistance and inductance across the line at equal distances along it. The third system, due to C. J. Reed, consists in dividing the whole circuit into a series of circuits, connected together by transformers in such a way that the secondary of any transformer forms a closed circuit with the primary of the next transformer. Or, we may say, the line on the Reed system is divided into a number of equal parts connected together by mutual inductance.

The results of the mathematical discussion of these systems may be stated briefly as follows: A loaded conductor of the Pupin type behaves like a uniform conductor with greater inductance per unit length than the original unloaded conductor; a loaded conductor of the Thompson type behaves like a uniform conductor with smaller resistance per unit length than the original unloaded conductor; whereas in a loaded conductor of the Reed type both these beneficial effects may be combined. E. H. B.

DISCHARGE AND OSCILLATIONS.

1305. *Characteristic Curves for Electric Discharges in Rarefied Gases.* **E. Riecke.** (Ann. d. Physik, 4. 3. pp. 592–616, March, 1901.)—When an electric current passes through a gas in a Geissler tube, the relation between potential difference and current is much more complicated than that given by Ohm's law. For a given tube this relation can be exhibited in the form of a "characteristic curve." The tube used by the author was a sphere of 5·9 cm. radius. Tables and curves are given illustrating the effects of magnetic action and change of pressure on the form of the characteristics. D. E. J.

1306. *The Delay of Discharge through Magnetic Force.* **J. Stark.** (Phys. Zeitschr. 2. pp. 382–383, March 30, 1901.)—It has been shown by Warburg that if a transverse magnetic field be created in the space between two electrodes in a rarefied gas, and if now a gradually increasing potential difference be established between them, then the presence of the field delays, in some cases several minutes, the passage of the luminous discharge. J. J. Thomson and Warburg explain this by supposing that there are in the gas, previous to the visible discharge, a number of ions; by the action of the electric field this number is gradually increased, thereby increasing the conductivity of the gas, until finally the current they carry is sufficient to render the discharge luminous. The magnetic field, on the other hand, tends to displace the moving ions in a direction at right angles to that joining the electrodes, thereby diminishing the conductivity. Stark considers that the ions are made to move in spiral paths and so move very little towards the opposite electrodes. The effect is found to be much greater when the anode is removed some distance and the kathode is placed in the magnetic field; a diminution of pressure brings about the same result. This arises from the fact that the negative ions move much quicker than the positive ones, and the less the pressure the greater their velocity. R. S. W.

1307. *Silent Electric Discharge.* **S. Leduc.** (Comptes Rendus, 132. pp. 542–543, March 4, 1901.)—The author describes some further remarkable properties of the silent electric discharge, or "electric effluvium," whose physical and chemical effects he has latterly been investigating. He produces it by rapidly charging and discharging a condenser consisting of a metallic sphere on the one hand, and a sheet of aluminium with a central perforation on the other hand, separated by a plate of glass or celluloid. The central portion of the plate is on both its faces the origin of violet and ultra-violet rays, which can be concentrated by a quartz lens. These rays produce an intense fluorescence on a platino-cyanide screen without concentrating the beam, and photographic effects are obtained which surpass in intensity those produced by sunlight. The rays are particularly valuable for Finsen's treatment of anæmic tissues. These are compressed by means of a quartz plate contained in an ebonite frame, which directly adjoins the aluminium sheet forming one armature of the condenser. The diseased tissue is thus exposed to rays which have only to traverse a thin plate of quartz. The apparatus may be worked with an induction coil or an influence machine. E. E. F.

1308. *Velocity of Ions drawn from the Electric Arc.* **C. D. Child.** (Phys. Rev. 12. pp. 137–150, March, 1901.)—It has been previously found [Abstract No. 847 (1901)] that the velocity of the positive ions drawn from the flame of a Bunsen burner is slightly less than that of the negative ions, viz., 2·2 cm. per sec. for the + ions and 2·6 cm. per sec. for the — ions for a potential gradient of 1 volt per cm. The same method has now been applied to the ions drawn from an arc, with the result that the positive ions are found to move faster than the negative ions in the ratio of about 2 to 1. This effect is not due to the ultra-violet light of the arc, and is reversed in the case of an arc between metals. A similar effect is obtained with carbon heated in an oxyhydrogen flame, but at lower temperatures or with no carbon in the flame the phenomena resemble those obtained with a Bunsen burner. T. M. L.

1309. *Number of Ions in Air Saturated by Phosphorus Emanations.* **C. Barus.** (Science, 13. pp. 501–503, March 29, 1901.)—A short theoretical discussion based on earlier experiments [see Abstract No. 1772 (1900)]. These experiments show that when ionised air is passed through a charged tubular condenser, only an insignificant number of the ions take part in the electric current radially through the condenser, and the author gives a mathematical analysis to show that the phenomenon of leakage in a plate condenser may be fully explained by taking account of the ions which wander *laterally* out of the field of force. W. C. H.

1310. *Rotations Produced by Electric Sparks.* **A. G. Dell.** (Elect. World and Engineer, 37. pp. 513–515, March 30, 1901.)—A mica disc is coated with shellac and rotates in a horizontal plane. Spark discharges, of a maximum length of ¾ inch, pass under the disc on one side. When the disc is made sensitive enough as regards freedom of rotation and balancing, it starts to rotate from the + to the — pole. If started in the opposite direction it also continues to rotate in that direction without reversal. When moisture is carefully removed from the disc, the direction of rotation becomes more and more arbitrary. Heat reduces the velocity of rotation, and to some extent increases the starting velocity required to send it in the direction from — to +. When, instead of using jewelled bearings, the axle of the wheel is magnetised and suspended by a magnet pole, it is possible to obtain rotations from a 1½-inch spark with the disc raised ¾ inch above the spark path. On making the disc into a small condenser a curious phenomenon was observed by the author. The disc started in the direction +, stopped, started again several times, then suddenly started in the opposite direction, reversed again, and finally came to a total stop. E. E. F.

1311. *Colouration Produced by Radiation.* **E. Goldstein.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 10. pp. 222–229, Feb. 21, 1901.)—It is well known that alkali salts show various colours when exposed to the action of kathode rays. Goldstein shows that other salts may also become coloured. These colours may be divided into two classes : (1) Those which disappear rapidly when exposed to daylight ; (2) Those which do not disappear under these conditions, or at least disappear very slowly. The colours of the first class are produced by exposing the salt to kathode rays for a short time, the temperature being that of the room. Heating the salt generally causes their disappearance. Those in class (2) only appear when the substance is heated, the rays impinging at the same time, daylight itself not causing their disappearance except after some months. The same substance may therefore give colours of each class. The rays themselves may be used as the heater. Both colourations can be produced in gases at a pressure as high as 50 mm. although the time then required is considerably longer than for lower pressures. The positive light, ultra-violet light, and radio-active substances are all more or less efficient agents in their production. The author compares the various effects produced by kathode rays, "entladungstrahlen," and the radiation from radio-active substances with those produced by ultra-violet light, and arrives at the conclusion that they are all due to ultra-violet light of very short wave-length. R. S. W.

1312. *Coherer.* **T. Tommasina.** (Comptes Rendus, 132. pp. 627–628, March 11, 1901.)—This is a special coherer. In an ordinary coherer of carbon or filings the particles should be as free as possible; in this instrument the author places the filings in an insulating paste, the pressure on which can be adjusted by pistons pressing on it at each end of the tube in which the paste rests. The paste is made preferably of glycerine mixed with sulphur, lycopodium or silica, and the filings are of silver. When a discharge passes in the instrument its resistance is reduced, as is usual, but the author considers that there is a great advantage in replacing air by this liquid dielectric between the particles. The *rôle* of the powder is to hinder permanent coherence and to distribute pressure.

No relay was used when the instrument was used to take up signals across a large hall. The signals are heard by a telephone which is in series with the coherer and the cells. Ph. E. S.

1313. *Coherer Action.* **P. E. Shaw.** (Phil. Mag. 1. pp. 265–296, March, 1901.)—This paper is a very valuable contribution to our knowledge of the nature of coherence between metallic particles due to the incidence of electromagnetic waves. The coherer is here reduced to its elements—two wires at right angles to each other and touching at one point—and the force of coherence is measured. One of the wires projects horizontally from the suspended moving coil of a galvanometer, while the other is fixed vertically to the galvanometer stand. The force of coherence is measured by the current in the galvanometer coil necessary to separate the wires. In some experiments on the distance of separation over which coherence could take place the Electric Micrometer was used. The coherer was joined up in circuit with a battery, ammeter, and voltmeter, so that the resistance at the point of contact could be easily measured.

The following are some of the conclusions arrived at :—

1. The insulating layer between the surfaces of the contact is of importance before the first coherence has occurred. A layer of condensed air or gas might produce the well-known resistance. Oxide as such asserts itself when strong currents pass with certain easily oxidised metals, but this is a special case and does not affect the above statement.

2. In certain cases there actually is a bridge of metal formed between the surfaces and rigidly connected to both.

3. A peculiar molecular change (called orientation) has been brought to light. After coherence has taken place and the current has passed through the coherer in one direction, suppose decoherence to be brought about so that no current now passes; if then the direction of the e.m.f. in the coherer circuit be reversed, coherence immediately occurs. J. B. H.

1314. *Testing Coherers.* **C. Kinsley.** (Phys. Rev. 12. pp. 177–183, March, 1901.)—Experiments are described which show that the sensibility of a coherer is indicated by the steady potential which must be applied to it in order to cause it to "cohere." The same coherers were tested in the laboratory and on a telegraph station of the U.S.A. Signal Corps. The average of twenty-four experiments, in each case, gives 2·2 volts as the breaking down potential for one of the coherers, 3·8 volts for a second, and 5·5 volts for a third. The first, when tested telegraphically, proved to be more sensitive than the second, and the second than the third. The final value of the resistance when broken down is very different for coherers of the same sensibility. This necessitates alterations in the adjustment of the relay to suit each coherer in order to obtain the best results. Coherers of any desired degree of sensitiveness may be made from any metal by taking the proper precautions, the most important being that the filings should be perfectly free from oxidation. J. E.-M.

1315. *Oscillator for Stationary Electric Waves.* **Bernouilli.** (Electrician, 46. pp. 737–738, March 8, 1901.)—The apparatus is intended for the production of stationary waves in a pair of long parallel wires, as in Hertz's experiments. The primary consists of two semicircular conductors, terminated in small brass spheres, which are connected to the secondary of a high-frequency coil. Directly below the primary, and in a parallel plane, is the secondary of the oscillator, which is a wire bent into a circle of the same radius as that formed by the primary. Primary and secondary are enclosed in a vessel containing oil. The ends of the secondary are connected to the long parallel wires. When the primary spark-gap is properly adjusted the wires are luminous along their entire length. If conducting bridges be now placed at the proper places to give stationary waves all the nodes become dark, the rest of the wire remaining luminous. J. E.-M.

1316. *Propagation of Electric Waves through Water.* **C. Gutton.** (Comptes Rendus, 132. pp. 543–545, March 4, 1901.)—When the electric and magnetic properties of an insulator only depend upon its dielectric constant, the wave-length of a resonator remains the same when measured first in air and then in the insulating medium in question. This proposition was deduced by Blondlot from considerations of homogeneity, and verified in the cases of castor-oil and ice. If the medium is magnetic or conducting, or if it shows considerable absorption for electric waves, its properties are no longer completely defined by its dielectric constant, and the equality of wave-lengths of a resonator in air and in the medium cannot be certain. This is the case with ordinary spring water, which shows a decided conductivity and consequent absorption of electric waves. The author therefore measured the wave-lengths of a simple resonator in air and in water, and found that they were practically the same when resonator and wires were either out in the air or immersed in water. He also found that the path traversed by the waves during one period of the resonator oscillating in air is 8·3 times smaller in water than in air. This implies that when a resonator is plunged into water its period of oscillation becomes 8·3 times greater than in air. E. E. F.

1317. *Reflection of Electric Waves by Metallic Surfaces.* **K. F. Lindman.** (Ann. d. Physik, 4. 3. pp. 617–637, March, 1901.)—Righi's results tending to show that waves reflected from a metallic surface may be ellipitically polarised are not confirmed by the author's experiments. He concludes that waves are not altered in type by such reflection. J. E.-M.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1318. *Gaseous Dielectrics.* **E. Bouty.** (International Physical Congress at Paris, Report, 2. pp. 341–364, 1900.)—This paper is divided into two parts: the first deals with the measurement of the dielectric constant K for gases and vapours by various physicists, notably Boltzmann, Klemenčič, Lebedef, and Ayrton and Perry. A brief and more or less critical account of the various methods used is followed by various tables in which the values of K that have been obtained are compared with the results of theory, in so far as concerns the refractive index and its variation with different conditions. The results are compared with those that are obtained from the Mossotti-Clausius and Lorenz formulæ, and the deduction drawn that if for a liquid K is not equal to the refractive index squared, neither is it equal to that quantity when the substance is in the state of vapour. The suggestion is made that the variation of K with temperature, measured experimentally, would be useful in explaining the various discrepancies between theory and experiment. The second part of the paper deals chiefly with what Maxwell calls the electric strength of a dielectric, and results of experiments still in progress by the author are introduced. R. S. W.

1319. *Deformation of a Dielectric in an Electrostatic Field.* **P. Sacerdote.** (Journ. de Physique, 10. pp. 196–200, March, 1901.)—The increase of length of a solid dielectric in an electrostatic field the author has shown to be given by [see Abstract No. 1907 (1899)]—

$$\frac{\Delta L}{L}=(a+k)\frac{KH^2}{8\pi}=(a+k)\frac{KV^2}{8\pi e^2},$$

in which e is the thickness of the dielectric, a the reciprocal of the elasticity modulus, and k a coefficient called the coefficient of variation of the dielectric constant by a tractive force perpendicular to the lines of force.

If the condenser has the form of a dielectric tube with two metallic tubes concentric with it, one inside and the other outside as armatures and separated from it by a dielectric liquid, then it is shown that the term in the above formula containing a disappears, and the formula becomes—

$$\frac{\Delta L}{L}=k\left(\frac{KH^2}{8\pi}\right)$$

Elongation experiments with such an arrangement might give us at least some information regarding the sign of k, if not its actual magnitude. [See also following Abstract.] J. B. H.

1320. *Elongation of a Dielectric in an Electrostatic Field.* **P. Sacerdote.** (Phil. Mag. 1. pp. 357–359, March, 1901.)—The experimental results obtained by L. T. More in his paper on this subject [see Abstract No. 2440 (1900)] are here criticised. More concluded that no electrical deformations of dielectrics exist, but the author shows that by the very disposition of More's experiments the tube should not experience any appreciable elongation; thus the negative result merely proves that the experiments were carefully performed.

The author refers to two papers on this subject of which More seems to to have been ignorant: one by himself [Abstract No. 1907 (1899)] and one by Cantone (Rendiconti della R. Acc. dei Lincei, ser. 4, t. IV., pp. 344–353, 471–

477, 1888), and then calculates the elongation which his formula gives when applied to More's arrangement. This elongation is found to be within the limits of experimental error. [See also preceding Abstract.] J. B. H.

1321. *Measurement of Insulation Resistance.* **Meller.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 12–19, March 21, 1901.)—The usual formula for the measurement of insulation resistance by the *leakage method* is—

$$R = \frac{t}{C \log\left(\frac{V_0}{V}\right)},$$

where R is the resistance, C the capacity, V_0 the initial potential difference, and V the potential difference after the lapse of t seconds.

The author finds that this formula gives incorrect results since R is a function of V, or, what amounts to the same thing, a function of t. It is found that R is a linear function of t, so that

$$R = at + b,$$

where a and b are constants. W. G. R.

1322. *Electric Conductivity of Quartz and of Glass.* **F. M. Exner.** (Deutsch. Phys. Gesell., Verh. 3. 4. pp. 26–30, 1901.)—The conductivity of a plate of amorphous quartz manufactured by Schott, of Jena, is here measured at temperatures between 100° and 150° C. The plate was clamped between two insulated steel vessels containing amalgam to serve as anode and kathode, and the condenser method of measuring high resistances was used. The specific resistance at temperature ϕ as compared with that of mercury at 0° is as follows:—

θ	S
101·0°	$4{\cdot}1 \times 10^{15}$
124·5	$2{\cdot}2 \times 10^{15}$
147·0	$0{\cdot}9 \times 10^{15}$

In these experiments the potential difference was 240 volts, and the thickness of the plate 9 mm., giving a potential gradient of 27 volts per mm. Sodium amalgam was used both as anode and kathode.—When an anode of mercury was used the numbers obtained for S were from five to six times greater than the above. A plate of rock crystal cut perpendicular to the principal axis had a specific resistance varying from $2{\cdot}3 \times 10^{12}$ to 5×10^{13} between the temperatures 109° and 148° C.

The conductivity of several glasses in the form of flasks suitable for Leyden jars was also measured at atmospheric temperature. J. B. H.

1323. *Experiments with Braun Tubes.* **H. T. Simon** and **M. Reich.** (Phys. Zeitschr. 2. pp. 284–291, Feb. 9, 1901.)—The authors describe with illustrations a stand for Braun tubes; it consists of an upright with cross arms, the tube passing through the centre of the cross, with its axis perpendicular to the plane of the cross. The arms of the cross are provided with grooves in which slide the coils used to deflect the rays. The authors point out the advantages of this apparatus in the lecture-room, when the rays are received on a fluorescent screen, and describe its use with a rotating mirror in showing alternate current curves, interrupter curves, hysteresis curves, oscillatory discharges, phase-differences, Lissajous figures, &c. G. H. B.

1324. *Acoustic and Electrical Constants of the Telephone.* **M. Wien.** (Ann. d. Physik, 4. 3. pp. 450–458, March, 1901.)—The condition of the correct translation of speech by a telephone receiver is that the relative amplitude of different tones remains unvaried. To determine how far this condition is fulfilled, the following three points must be examined :—(1) The variation of current with frequency, at constant e.m.f. (2) The variation of magnetic induction with frequency, at constant current. (3) The variation of the amplitude of the diaphragm at constant magnetic induction.

The author has made experiments on four telephones—a Bell receiver, two Siemens receivers, and an Apel receiver—all four transmitting speech with equal distinctness. Their effective resistances and self-inductions were measured for frequencies up to 16,000, the source of current being a siren alternator, giving a sine wave. The effective resistance increases very rapidly, being in one Siemens telephone, 13 times greater at a frequency of 16,000 than the true resistance. The self-induction, on the other hand, diminishes ; in the case of the other Siemens telephone from $1{\cdot}17 \times 10^8$ at frequency 256 to $2{\cdot}3 \times 10^7$ at frequency 16,000. Assuming with Helmholtz that the e.m.f. in the telephone circuit is proportional to the frequency, the current varies as $p/\sqrt{R^2 + p^2 L^2}$, where p is 2π × frequency, or, as R is small compared with L, as 1/L. For the Siemens telephone, the current would be 3·4 times as large at frequency 16,000 as at frequency 256, and the corresponding tone-intensity $(3{\cdot}4)^2 = 11{\cdot}5$ times greater. On the other hand, the magnetic induction, and with it the amplitude of the diaphragm and the tone-intensity, diminishes with the frequency. In the same telephone the tone-intensity would, for this reason, be 25 times smaller at frequency 16,000 than at frequency 256. The variations in tone-intensity due to these two causes tend to counteract each other, and the resulting variation with frequency must be determined for each single telephone.

The resonance tones of the diaphragm also have a considerable influence on the intensity of certain tones. The author has measured the frequencies which give resonance, and finds the more marked to be, in the Bell telephone, 1,100, 2,800 and 6,500, while in the Siemens, 720, 2,100 and 5,000. He has also measured the minimum current producing an audible tone, at different frequencies. For the Bell telephone this is, in units of 10^{-8} amperes, 19,000 at frequency 64, a minimum of 18 at 1,024, a second minimum of 70 at 2,800, and 12,000 at 16,000 ; while for the Siemens telephone there are minima of 0·8 and 1·0 at frequencies 720 and 2,400, rising to 1,200 and 1,700 at 64 and 16,000. All the telephones show maximum sensitiveness between frequencies of 500 and 3,000—frequencies which include the more important tones of the voice ; the very rapid loss of sensitiveness at lower and higher frequencies is probably due more to the ear than to the telephone. The author concludes that the telephone is very far from correctly reproducing a composite tone. G. H. B.

1325. *Modified Callendar-Griffiths Key.* **G. Kucera.** (Phys. Zeitschr. 2. pp. 381–382, March 30, 1901.)—If the magnetic system of a galvanometer is a light one and the instrument is in a very sensitive condition, the thermo-currents are very troublesome when it is a case of measuring rapidly changing resistances. If the circuit is such that great temperature differences at the various parts of it are unavoidable, as in platinum thermometry, then the Callendar-Griffiths key does not entirely get rid of them. The author shows how, by a simple addition, the key may be made more effective. In principle it consists in short-circuiting the branch in which the thermo-currents appear, so that the current produced tends to equalise the temperature differences at the junctions. R. S. W.

1326. *Dial Resistance Bridges.* **M. T. Edelmann.** (Elektrotechn. Zeitschr. 22. p. 257, March 21, 1901.)—The dial contacts are arranged in a circle, with the inside edges bevelled; a central circular piece, to which contact is made, has its outer edge bevelled in the opposite direction, this and the contact pieces forming an annular V groove. Contact is made between the two sides of the groove by two spring brushes, one bearing on each side of the groove; each brush consists of three springs, bearing on different portions of the bevelled edges. The brushes are fixed to a vertical shaft terminating in a handle which protrudes above a cover protecting the contacts and brushes. The resistance of the contact does not vary by 0·001 ohm. G. H. B.

1327. *Electrostatic Voltmeter for very High Pressures.* **G. Benischke.** (Elektrotechn. Zeitschr. 22. p. 265; also Discussion, p. 265, March 21, 1901. Paper read before the Elektrotechnische Verein, Jan. 22, 1901.)—The instrument is of the ordinary type of electrostatic voltmeter, made by the Allgemeine Elektrizitäts-Gesellschaft, for pressures up to 7,500 volts. It is also provided with a scale reading to 25,000 volts; for use at this pressure the circuit is connected to the terminals of three condensers in series, while the voltmeter is connected to one of the condensers. The scales, however, are not exactly in the ratio of 3 : 1 as the condensers are not usually exactly similar; each scale is therefore specially calibrated. The dielectric employed is micanite, and the condenser is fixed to the base of the instrument.

Discussion.—**Görges** gave particulars of the condenser employed by Siemens and Halske for the same purpose; micanite, however, was found unsuitable, as the capacity varied with age. The same firm now employs porcelain plates as dielectric; the condenser may be of exceedingly small capacity, two plates of 25 sq. cm. with dielectric 5 mm. thick being sufficient. G. H. B.

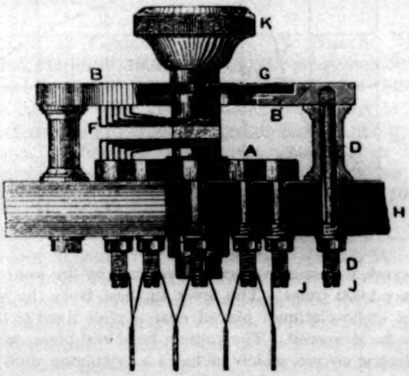
1328. *Electrolytic Contact-breaker.* **J. Härdén.** (Elektrotechn. Zeitschr. 22. pp. 257–258, March 21, 1901.)—The author first describes the difficulties met with in the continued use of the various contact-breakers now on the market, in connection with a coil giving 50 mm. sparks, and supplied by direct current at 135 volts. In the turbine mercury contact-breakers, the mercury very soon becomes too oxidised for use, and the edges of the contact teeth become eaten away; with a motor contact-breaker under petroleum the same difficulty was found. In the electrolytic contact-breaker of Wehnelt type, the platinum contact was worn away so rapidly as to form an expensive item in working. In Simon's type, either the glass wall cracked or the hole became enlarged till interruptions ceased.

The form designed by the author consists of an ordinary porcelain petticoat insulator, placed head downwards in an outer vessel of lead, forming the kathode and filled with acid; a 1·5 mm. hole was bored vertically through the head of the insulator, and a lead strip forming the anode was held in the insulator. A water-jacket surrounds the lead vessel, and the temperature is maintained at about 40° C. The contact-breaker works well, giving about 75 interruptions per second, and so far the hole has shown no signs of becoming enlarged. At first a glass tube was employed in the place of the insulator, which caused the phenomenon that when current was switched on the liquid in the tube was driven out; the interruptions then ceased, but were re-established by the liquid again entering the tube and rising above the outside level; it then began sinking, and the process was repeated continuously. With the insulator, however, the opposite effect was produced, namely, the liquid rose in the insulator when current was switched on, and then continued sinking and rising to a small degree, without ceasing to work; the insertion of an inductive resistance in the circuit diminished this effect.

G. H. B.

1329. *An Improved Lever-switch for Resistance-boxes.* **R. Franke.** (Elektrotechn. Zeitschr. 22. pp. 275–276, March 28, 1901.)—In this switch the spindle bearing the lever-arms does not serve as a conductor and is not subjected to any mechanical stresses when at rest, since the movable contact surfaces are arranged at the ends of a line perpendicular to the fixed contact surfaces which lie in two opposite parallel planes.

As shown in the Figure, a strong brass plate, B, in the form of a ring, is mounted on three columns, through one of which, D, the current passes to the ring. The brushes, F, transmit the current from B to one or other of the contact-blocks, A, these brushes being mounted on a spindle which can be turned by means of an ebonite handle, K. The resistance between A and B is about 0·0005 ohm in the laboratory form of the switch. A modification is shown, adapted for workshop use, in which the plate B is in the form of a disc supported on a central pillar, about which turns a sleeve bearing the brushes.



C. K. F.

1330. *A Simple and very Sensitive Quadrant Electrometer.* **F. Dolezalek.** (Deutsch. Phys. Gesell., Verh. 3. 2. pp. 18–22, 1901.)—The needle or needles in this quadrant electrometer are made of silver paper for lightness and are suspended on a quartz fibre. After the fibre has been attached to its end fastenings by sealing-wax, it is dipped into a solution of hygroscopic salt such as calcium or magnesium chloride. The fibre and wax thus get a thin coat of the salt which always contains sufficient moisture to make the surface conducting, so that the needle can be charged along the fibre. The instrument can be made extremely sensitive by choosing a fine fibre; with the needle charged to 110 volts and a fibre 0·009 mm. diameter, the period of the needle was 18 seconds and the sensitiveness 0·1 scale divisions at 2 metres distance for 4×10^{-5} volts.

The instruments are made by Bartels, Göttingen. J. B. H.

ALTERNATING CURRENTS AND MAGNETISM.

1331. *Magnetic Expansion of Iron and Nickel.* **P. E. Shaw and S. C. Laws.** (Electrician, 46. pp. 649–651, Feb. 22, and 738–740, March 8, 1901.)— By the aid of P. E. Shaw's Electric Micrometer [see Abstract No. 523 (1901)], the authors have been able to measure changes in length as small as 5×10^{-8} cm., and thus to investigate the curves, connecting magnetic field with change of length, very close to the origin. Bidwell, using an optical lever, measured to $1·4 \times 10^{-6}$ cm., and Nagaoka to 2×10^{-7} cm. The Electric Micrometer has a graduated screw, whose movement is reduced, by the joint action of a set of six levers, say 1,000 times. The lever furthest from the screw carries a contact bead of iridio-platinum placed near a plate fixed to the body whose movement is to be measured. The contact bead and plate, when they touch, complete an electric circuit, which includes a telephone used by the experimenter, and thus the exact position for contact can be ascertained with great delicacy. A description and diagrams are given of the arrangements used for the research. It was necessary to carefully protect the specimen from the heat of its exciting coil, as a rise in temperature of 1° C. would correspond to a reading of 10,000 scale divisions on the micrometer. Three iron rods were tested, of lengths 7·4, 7·7, and 7·9 cm., and of diameters 0·49, 0·26, and 0·10 cm.; the results are shown in curves A, B, C respectively in Fig. 1.

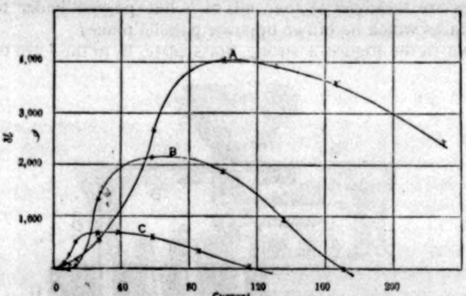


FIG. 1 —Iron Curves.

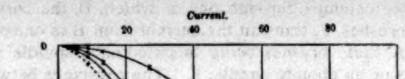


FIG. 2 —Nickel Curves.

The values of δl, the change in length, are in terms of 10^{-8} cm., and currents are given in hundredths of an ampere. The magnetising coil had 1,064 turns and was 8·6 cm. long. The smallest reading of δl for the thick bar was —9, but the scale of the curves is too small to show the readings close to the origin. A list of the actual readings is given in the paper.

Nickel was found to be easier to examine than iron on account of its smaller residual magnetisation, its uniform purity in different specimens, and the simpler character of its curves. Three rods were tested, having lengths of 7·6, 8·0, and 7·9 cm., and diameters 0·75, 0·19, and 0·10 cm. These are denoted D, E, F respectively in Fig. 2. The dotted curve is obtained by extrapolation, as explained in the paper, and gives the probable readings for a rod of infinitesimal diameter and of the same length as those tested. The scales are as given above. W. H. E.

1332. *Calculation of Permanent Magnets.* **J. Busch.** (Elektrotechn. Zeitschr. 22. p. 234, March 14, 1901.)—Taking the magnetomotive force of a permanent magnet as being about equal to the product of the length of the magnet, and the coercive force corresponding to the flux in the steel, the length of magnet required to produce a certain flux (B) in a short air-gap (l) is Bl/coercive force. Additional length must be allowed in order to overcome the reluctance of the magnet itself and the pole-pieces. The author finds that the actual flux agrees with his estimate within 10 per cent. in practical cases. W. H. E.

1333. *Permanent Magnets.* **I. Klemenčič.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 827–836, 1900.)—The causes of decrease of magnetic moment with time are discussed in this paper. Hansteen tried to express the change of moment with time by a formula which was only in rough agreement with the results of experiment. Lamont, who showed that it depended on the temperature fluctuations throughout the year, considered it doubtful whether the loss of strength at the beginning and later was according to one and the same law. Klemenčič takes up this view, and assigns the loss chiefly to two causes: one, the after effects of magnetisation, which are responsible for the greatest loss, occurring in the first two days after magnetisation; and the other, the changes in molecular structure which are brought about by previous deformations, and especially by former temperature changes such as those by which the steel is hardened. Losses due to the second cause go on slowly, and are coincident with slow changes in other physical properties of the steel. Tables are given, from a previous paper [see Abstract No. 139 (1901)], which show that change of magnetic moment with time cannot be expressed by a simple formula such as Hansteen's. Klemenčič finds that the secular change has a factor depending on the time of year, although his magnets were, unlike Lamont's, kept in a heated room, and were not subject to great temperature oscillations, summer or winter. The greatest loss of moment takes place in the summer months, little or none in winter. G. E. A.

1334. *Residual Magnetism.* **C. Fromme.** (Ann. d. Physik, 4. 4. pp. 853–856, April, 1901.)—The author refers to Holitscher's experiments on residual magnetism [Abstract No. 646 (1901)], and claims that most of his results had been already shown by himself; the remaining conclusions arrived at by Holitscher the author criticises as incorrect in general, and attributes them to the fact that the experiments were confined to a single specimen of iron. Holitscher found that when, by repeated application of a certain magnetising field, the residual magnetism had reached a limiting value, not only a stronger field but also a weaker field increased the residual magnetism, but that no field, of whatever strength, provided it were in the same direction, could diminish it. The author, on the contrary, found that the application of a slightly weaker field increases the residual magnetism, but that a considerably weaker field diminishes it, and that there exists a certain field of intermediate strength which does not change it. Holitscher further found that the residual magnetism increased with the time of magnetisation, without reaching a limit in the experiments; this is contrary to Frankenheim's experience, and the author attributes Holitscher's continued increase rather to the repeated application of the magnetising field than to the time of magnetisation. G. H. B.

1335. *Magnetic Precession.* **A. Schuster.** (Phil. Mag. 1. pp. 314–324, March, 1901. Paper read before the Physical Society of London, Dec. 14, 1900.)—Hertz showed that the most delicate method of investigating the influence of inertia is based on the apparent e.m.f.'s which are induced by the motion of conductors. If electricity possesses inertia, rotation of a body through which currents pass affects the flow of these currents in the same manner as the earth's rotation affects the direction of currents of air on its surface. Hertz obtained only negative results, but could fix an upper limit to the possible inertia of electric currents. It occurred to the author that this inertia, even if below the limits given by Hertz, might show accumulated effects when the currents last for a sufficient time. If the earth's magnetism be due to electric currents, the effects of inertia might explain secular variation. The present investigation shows that inertia would indeed cause a "magnetic precession" precisely of the character of the secular variation, but that this precession would be very much slower than the variations which are actually observed. [See also Abstract No. 1095 (1901).] E. E. F.

MEDICAL ELECTRICITY.

1336. *Energy Transformation in the Organism.* **A. Broca.** (International Physical Congress at Paris, Report, 3. pp. 495–522, 1900.)—In the first thermodynamical part, the author wishes to show that the muscular phenomena, though neither reversible nor probably electrical in nature, are analogous to those of the electric pile. Stress is laid upon the observation, made by the author and Richet, that the cooling which takes place during the first moments of muscular contraction is independent of the temperature of the body, but dependent upon the percentage of oxygen in the blood, and may, in want of oxygen, mask the heat generation; in such a case, the muscle appears rigid and unexcitable. The second part deals with the return of the excited organ to equilibrium. According to the author and Richet, the grey substance of the brain responds to electric excitation only by one wave which resembles Kelvin's e.m.f. wave in cable signalling, so that there must be something in the grey matter capable of reacting by a kind of impulse of the opposite direction. The refractory period, during which the grey substance does not respond to any fresh impulse, is 0·1 second. For the electrically excited nerves themselves, Charpentier has observed a wave period of $\frac{1}{800}$ second, the wave travelling 28 m. per second in a frog's nerve. The paper further refers to Charpentier's retinal undulations, based upon the study of the black bands observed when an opaque disc, out of which a sector has been cut, revolves in front of a source of light. H. B.

REFERENCES.

1337. *Coherers.* **G. Schlabach.** (Phys. Zeitschr. 2. pp. 374–376, March 23, and 383–387, March 30, 1901.)—A full notice of the bibliography of the subject.

1338. *Therapeutic Use of Ozone.* **H. Bordier.** (Archives d'Él. Médicale, 9. pp. 16–35, Jan.; and 85–103, Feb., 1901.)—Report to the French Association for the Advancement of Science.

1339. *Standard Cells.* **G. Gouy.** (International Physical Congress at Paris, Report, 2. pp. 422–439, 1900.)—A summary of the present state of our knowledge on this subject. W. R. C.

1340. *Field of Slowly Moving Electrons.* **C. H. Wind.** (Archives Néerlandaises, 5. pp. 609–635, 1900.)—This paper contains a mathematical treatment of the properties of the field produced by the movement of electrons and a deduction of the elementary electromagnetic and electrodynamic laws from the electron theory. The electron is regarded as a spherical shell uniformly charged throughout its volume, but for comparison there are given the different results arising from regarding the shell as very thin, or as a solid sphere. W. E. T.

1341. *Counter E.M.F. in the Electric Arc.* **V. v. Lang.** (International Physical Congress at Paris, Report, 3. pp. 183–196, 1900.)—This paper gives a *résumé* of the experiments and theories on the fall of potential across the electric arc from 1860 to the present date. E. C. R.

1342. *Dispersion in Metals.* **P. Drude.** (International Physical Congress at Paris, Report, 3. pp. 34–46, 1900.)—An account is given of the author's theory [see Abstract No. 1833 (1900)] of dispersion in metals based on the consideration of electrons, and of its agreement with the results of experiment and the known properties of metals. In addition to points referred to in that Abstract, attention is drawn to the possibility of deducing the number and mobility of the conducting electrons from the other properties of the metals, of calculating the constants of the insulating electrons from their optical properties, and of inquiring further into the question of the variation of the electric conductivity of metals with temperature. W. E. T.

1343. *Equations of Electrodynamics for Moving Bodies.* **E. Cohn.** (Archives Néerlandaises, 5. pp. 516–523, 1900.)—A mathematical discussion of Maxwell's, Hertz's, and Lorentz's electromagnetic equations, and their measure of accord with experimental facts. E. H. B.

1344. *Electrodynamical Laws.* **E. Wiechert.** (Archives Néerlandaises, 5. pp. 549–573, 1900.)—A mathematical treatment of electromagnetic theory based on the work of Maxwell, Hertz, and Lorentz. E. H. B.

1345. *Coherers.* **E. Branly.** (International Physical Congress at Paris, Report, 2. pp. 325–340, 1900.)—A summary of this subject. Mention is made of the materials and conditions of their use for the making of sensitive coherers. Some experiments are given which prove that a certain large voltage, about 200, is the most effectual. The theories of Branly and Lodge are compared and are weighed in connection with present known facts. P. E. S.

1346. *Effect of Current Variations on a Steel Needle and an Iron Disc.* **M. Hornemann.** (Ann. d. Physik, 4. 3. pp. 481–512, March, 1901.)—A compendium of comparative experiments on the behaviour of a steel needle and of a soft iron disc, when suspended in turn at the centre of a coil through which a current is passed or reversed, or through which the discharges from a Leyden jar or an influence machine are passed. G. E. A.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1347. *Approximation of Atomic Weights to Whole Numbers.* **R. J. Strutt.** (Phil. Mag. 1. pp. 311-314, March, 1901.)—The fact that a very large number of atomic weights approximate to whole numbers is here treated as a problem in probabilities, and the chance of their being so near to whole numbers is calculated, supposing the atomic weights had been fixed by chance alone.

The differences between the atomic weights and the nearest whole numbers are taken and summed, and the chance that this sum is as small as the observations make it is calculated. Thus, taking the eight elements whose atomic weights are known to the third decimal, the chance works out at 1 in 1,000; taking 27 elements whose atomic weights are known to the second decimal, the chance is 1·7 in 1,000.

It appears, then, that the atomic weights tend to approximate to whole numbers far more closely than can reasonably be accounted for by any accidental coincidence. J. B. H.

1348. *Molecular Weights and Constitutional Formulæ.* **Lespieau.** (Soc. Franc. Phys., Bull. 165. pp. 3-4, 1901.)—Apart from the atomic theory and Avogadro's hypothesis, the study of the chemical reactions of a compound enables a constitutional formula, and hence a molecular weight, to be assigned to it. The agreement between the results thus obtained by purely chemical means and those based on physical data is a strong argument in favour of the atomic theory. N. L.

1349. *Compressibility of Solutions.* **Guinchant.** (Comptes Rendus, 132. pp. 469-472, Feb. 25, 1901.)—Experiments were made on the less complex solutions, such as those of organic compounds in water, in the hope of finding simpler and more general laws than the very varied ones hitherto given. It was sought to find an expression for the variation of the volume of the dissolved body with pressure. By the volume of the dissolved body is meant the difference between the volume of the solution and the volume of the solvent, and the author finds that the volume of the dissolved body is independent of the pressure, at least up to the pressure of 4 atmospheres. It seems, then, that the variation of volume which accompanies the simple solution of a body in water is due to a variation in the state of aggregation of the solvent rather than to the volume occupied by the dissolved molecules. The method of observation employed by the author was a method of comparison analogous to that of Schneider [Röntgen and Schneider, Wied. Ann. 29. p. 165]. J. J. S.

1350. *Study of Growing Crystals by Instantaneous Photomicrography.* **T. W. Richards** and **E. H. Archibald.** (Amer. Acad., Proc. 36. pp. 341-353, March, 1901.)—Frequent photomicrographs of crystals of various substances were taken during their birth and growth, an enlargement of four thousand diameters being obtained. The salts examined—potassium iodide, barium chloride, copper sulphate, &c.—were crystallised from aqueous solution, and both polarised and ordinary light were employed. No properly focussed image on any of the plates seemed to be devoid of crystalline structure. The growth of the crystals is much more rapid in the first than in the later stages, the cube of the diameter being very approximately proportional to the time. The conclusion is arrived at that whatever theoretical reasons there may be for believing that crystals always develop from a transitory liquid phase, the present experimental evidence is inadequate to prove that the globules of such a phase attain a size visible in the microscope, except in the case of substances having melting-points not far from the temperature of crystallisation. The paper, which is illustrated by three plates and a diagram, is regarded as suggestive of a mode of study rather than as a finished treatment of the subject. N. L.

1351. *Method of Obtaining Crystals in a Solution without Formation of a Superficial Crust.* **A. Wróblewski.** (Acad. Sci. Cracovie, Bull. 8. pp. 319–325, 1900. Also Zeitschr. Phys. Chem. Jan. 22, 1901.)—The formation of a superficial crust is often a serious obstacle to the production of pure, well-formed crystals of organic substances by the ordinary methods. In the apparatus here described and figured the solution is placed in a tube, closed at the bottom by a parchment membrane, which fits closely into a bottle containing calcium chloride. Evaporation takes place through the membrane from the lower layers of the solution, the aqueous vapour being absorbed by the calcium chloride. N. L.

1352. *So-called Liquid Crystals.* **G. Tammann.** (Ann. d. Physik, 4. 3. pp. 524–530, March, 1901.)—Crystals of certain substances, notably *p*-azoxyanisol and *p*-axoxyphenetol, although perfectly clear in the solid state, when melted give rise to turbid liquids which appear bright when viewed between crossed Nicols. Lehmann has explained this behaviour by supposing that such compounds retain their crystalline structure in the liquid state. The author regards this view as by no means proven, and considers the turbid liquids obtained from the two above-named substances as emulsions of a brown reduction product which is formed in large quantity in the preparation of the esters from *p*-nitrophenol, the change from the turbid to clear liquid at a higher temperature being due to the greater solubility of the reduction product. It is pointed out that mixtures of powdered glass and water, emulsions of phenol and water, as well as other turbid non-crystalline media, give a bright field between crossed Nicols, and this to a greater extent as the particles in the turbid medium are made finer and more numerous. The fact that, when rotated between crossed Nicols, such liquids show definite directions of extinction is no proof of their crystalline character, and the great stability of the distribution of the dark and light portions of the field, which are altered neither by rapid and great changes of temperature nor by briskly moving the liquid by pushing the cover-glass to and fro, shows that the change in brightness of the field on rotation of the liquid is not due to double refraction peculiar to the so-called liquid crystals, but to the adhesion of the fine particles of the emulsion to the cover-glass.

An objection which may be urged against the author's theory is that when such liquids are heated a sudden change in their volume occurs at the point where the turbidity disappears. This fact was noted by Schenck, whose data show that the coefficient of expansion of the turbid liquid increases rapidly with rise of temperature, so that it is possible that the isotherms of the turbid liquid are continuous curves having a sharp change in direction at the temperature at which the liquid becomes clear.

Experiments made by the author with *p*-azoxyanisol and cholesteryl benzoate seem to indicate that they are not homogeneous chemical compounds, but no certain result is arrived at. T. H. P.

1353. *Pressure-volume Diagram.* **P. Saurel.** (Journ. Phys. Chem. 5. pp. 179–181, March, 1901.)—The author calls attention to the usefulness of the limiting lines in the volume-pressure plane corresponding to the network referred to by Duhem [see Abstract No. 1151 (1901)] for the pressure-temperature plane in the case of the binary system formed by two liquefiable gases. If a two-phase system of mean concentration S be in equilibrium at temperature T and pressure π, we can determine the concentrations S_1 and S_2 of the phases from the network in the T, π plane. A line now drawn in the v, π plane parallel to the volume axis through the known point v, π (v being the mean specific volume) intersects the dew line of the mixture S_1 at a point v_1, π and the boiling line of the mixture S_2 at a point v_2, π, where v_1 v_2 are the specific volumes of the vapour and liquid phases. Moreover, the point v, π divides the line (v_2, π), (v_1, π) in the ratio of the masses of the phases. W. E. T.

1354. *Fundamental Equation of a Multiple Point.* **P. Saurel.** (Journ. Phys. Chem. 5. pp. 170–178, March, 1901.)—The author deduces mathematically a relation between the slopes of the intersecting curves at any multiple point, corresponding to the relation known to exist between the slopes of the three curves, which represent in the pressure-temperature plane the equilibrium of three one-component univariant systems. It is shown that the equation may be written in the form—

$$\Sigma_1^{n+2} Q_i \frac{dT_i}{d\pi_i} = 0$$

where Q denotes the heat absorbed by the *i*th univariant system during the corresponding change at the multiple point, and T is the temperature of the multiple point. W. E. T.

1355. *Dissociation Studies. II.* **W. D. Bancroft.** (Journ. Phys. Chem. 5. pp. 182–192, March, 1901.)—The phenomena exhibited by the various forms of ethyl aldehyde are discussed in the light of Duhem's theory. When no catalytic agents are present, acetic aldehyde and paraldehyde behave as one component system and mixtures of them as two component systems.

When a catalytic agent ($COCl_2$, HCl, SO_2, $ZnCl_2$, $CH_3.COCl$, $Cu_3.COBr$, H_2SO_4, $(CN)_2$, C_2H_5I) is present, a reversible equilibrium is attained if the speed of working does not exceed the velocity of reaction. This consideration offers a satisfactory explanation of the experimental facts so far as acetic aldehyde and paraldehyde are concerned.

When metaldehyde comes into the question the state of affairs is not so clear. It seems that metaldehyde must be regarded as an isomeric form of paraldehyde which, in presence of a sufficiently powerful catalyser, passes into the latter form. It stands, therefore, as an intermediate form between acetic aldehyde and paraldehyde. Theoretically there must be a temperature above which metaldehyde will liquefy to a mixture of acetic aldehyde and metaldehyde, and below which acetic aldehyde will solidify completely to metaldehyde, provided always that the change of metaldehyde into paraldehyde be prevented. [See further Abstract No. 1222 (1899).]

F. G. D.

1356. *Electromotive Behaviour of Substances with Several Degrees of Oxidation, II.* **R. Luther.** (Zeitschr. Phys. Chem. 36. pp. 385–404, March 12, 1901.)—The e.m.f. of the reaction $Cr''' \longrightarrow CrO_4''$ is about $-1{\cdot}8$ volts, and of Cr (metal) $\longrightarrow CrO_4''$, probably about 0·9 volts.

The equilibrium between cupric and cuprous sulphate in presence of metallic copper was determined by titrating the cuprous salt with potassium permanganate. The equilibrium-constant, $Cu''/(Cu')^2$, was found to be $1{\cdot}5 \times 10^6$ at 25° C.

The e.m.f. of the system

$$Hg \mid HgCl_2\ (1\ \text{mol. in } 50\ \text{l.}) \mid KCl\ (1\ \text{mol. in } 40\ \text{l.})\ \text{is } -0{\cdot}750\ \text{volts};$$

from this it is calculated, by means of Nernst's formula, that the dissociation constant of mercuric chloride in aqueous solution is about $0{\cdot}5 \times 10^{-14}$. [See further Abstract No. 2467 (1900).] T. M. L.

1357. *Electro-chemical Relations of the Allotropic Forms of Silver.* **Berthelot.** (Comptes Rendus, 132. pp. 732–734, March 25, 1901.)—Four different forms of silver were examined, namely, (1) silver modified by the action of oxygen at about 550°, (2) silver precipitated by copper, (3) the same as (2) with subsequent heating, and (4) crystallised silver. Each of these in turn was made the electrode in a bath of 10 per cent. silver nitrate solution, and was connected by means of a wire and a galvanometer to the other electrode consisting of amorphous silver. In each case an immediate current was noticed, the amorphous silver being positive towards the other forms. The current thus developed diminishes rapidly at first and in less than a minute reaches an almost fixed value, which then gradually falls to zero. The currents could not be measured. T. H. P.

1358. *Dielectric Constants of Nitriles.* **H. Schlundt.** (Journ. Phys. Chem. 5. pp. 157–169, March, 1901.)—The dielectric constants of a number of nitriles were determined by Drude's method (Zeit. Phys. Chem. 13. 531, 1893), the cells used being calibrated with benzene, acetone, water, mixtures of benzene and acetone and of acetone and water. The results obtained are shown in the following table :—

Solvent.	Formula.	Temp.	Dielectric Constant (Air = 1)
Hydrocyanic Acid ...	HCN	21	95
Acetonitrile	$CH_3.CN$	21	36·4
Propionitrile	$C_2H_5.CN$	22	26·5
Butyronitrile	$C_3H_7.CN$	21	20·3
Isopropyl cyanide ...	$CHMe_2.CN$	24	20·4
Valeronitrile	$C_4H_9.CN$	21	17·4
Isobutyl cyanide ...	$CHMe_2.CH_2.CN$	22	17·95
Capronitrile	$CHMe_2.CH_2.CH_2.CN$	22	15·5
Benzonitrile	$C_6H_5.CN$	21	26·0
Benzyl cyanide ...	$C_6H_5.CH_2.CN$	21	14·9
o-Toluonitrile	$C_6H_4Me.CN$	23	18·4
Pyridine	C_5H_5N	21	12·4
Quinoline	C_9H_7N	21	8·8

In accordance with the Nernst-Thomson law that conductivity is determined by the dielectric constant of the solvent, it might be expected that the nitriles with high dielectric constants would be good conductors; the law holds good for the homologous series of aliphatic nitriles, as is shown by the following table of molecular conductivities of silver nitrate in these solvents at 25° C. :—

Solvent.	v.	μ_v	Dielectric. Constant
Acetonitrile	64·0	103·7	36·4
Propionitrile	63·7	46·0	26·5
Butyronitrile	75·6	25·4	20·3

But a solution of silver nitrate in propionitrile conducts about four times as well as a solution in benzonitrile, which has a slightly larger dielectric constant, and a solution in pyridine conducts better than a solution in butyronitrile, whose dielectric constant is nearly twice as large.

The most interesting result given in the paper is the exceedingly high dielectric constant of hydrocyanic acid ; this bears the same relationship to acetonitrile that water bears to methyl alcohol, or formic to acetic acid, and it is to be expected that it will give solutions of proportionately high conductivity. Measurements in this direction are in progress. T. M. L.

1359. *Spectrophotometric Study of the Hydrolysis of Dilute Ferric Chloride Solutions.* **B. E. Moore.** (Phys. Rev. 12. pp. 151–176, March, 1901.)—The author applies the spectrophotometric method to the examination of the hydrolysis of ferric chloride in aqueous solution, which was studied electrolytically by Goodwin in 1896. According to the latter author, part of the ferric chloride exists in the form of the ions Fe and 3Cl and the rest as the ions FeOH, H and 3Cl. At any time after diluting the solution, a certain number of the FeOH ions have disappeared, forming with water a colloid hydrate $(FeO_3H_3)_x$, so that at any instant there are present four components from which absorption of light may be expected, namely $FeCl_3$, Fe, FeOH, and $(FeO_3H_3)_x$. The author first discusses the theoretical aspect of the subject and the arrangement and method of using the apparatus employed, and afterwards gives tables of the numerical results and absorption curves plotted from them. The results show that a study of the absorption spectra is a good method for following the progressive changes in the formation of colloid hydrate and is useful whenever colour changes take place. Ionisation is detected and the non-transparency of the ions demonstrated, but no quantitative determination of the rate of ionisation is possible in the case studied. But slight evidence is exhibited for the existence of the two iron ions clearly indicated by the electrolytic method of examination, but the general agreement of the optical with the electrical method of finding the rate of formation of the final products leads to an acceptance of Goodwin's theory. It is possible that the molecules of the final product are not all of the same magnitude, that is, the value of x in the formula $(FeO_3H_3)_x$ is variable. The optical study of absorption spectra in regard to their relation to the molecular structure of solutions, is not so readily applied as the boiling-point, freezing-point, or conductivity method, but may be useful in showing complexity of structure not brought out by these other methods. T. H. P.

1360. *Softened Positive Accumulator Plates.* **F. Peters.** (Centralblatt für Accumulatoren, 1. pp. 125–128, 1900.)—After a certain number of discharges the active material of lead peroxide plates becomes soft and slimy, and finally drops from the grid. An exhaustive chemical analysis of the material from normal and from softened plates shows that in the latter case the material from the centre of the mass is considerably richer in available oxygen and in peroxide than that from the surface, whilst in the normal plates the difference is but slight. In explanation of this it is suggested that the continued expansions and contractions caused by the charging and discharging of the accumulator bring about a loosening of the active material whereby the formation of peroxide in the interstices is favoured, whilst in the superficial layers the porosity and consequent imperfect contact with the grid is prejudicial to peroxide formation. The behaviour of the cell on discharging is shown to be in accordance with this explanation. The resistance of the active material is not appreciably altered by the softening. N. L.

1361. *Thermo-chemistry of Standard Cells with Dilute Solutions.* **W. Jaeger.** (Deutsch. Phys. Gesell., Verh. 3. 5. pp. 48–53, 1901.)—The e.m.f. of a Clark cell containing a zinc sulphate solution saturated at 6·75° was measured between + 40° and — 10°; this solution contains 1 mol. $ZnSO_4$ to 19·77 mols. H_2O, and the e.m.f. of the cell is represented by the formula $E_v = 1·44220 - 0·0005300(t - 6·75°)$. By applying Helmholtz's equation this gives the value 80170 cal. for the chemical energy of the cell.

The difference between the e.m.f. of this cell and that of a Clark's cell at temperatures above or below 6·75° gives a measure of the heat of solution of $ZnSO_4 . 7H_2O$ in a solution of the composition $ZnSO_4 + 19·77\,H_2O$; this is calculated from the experimental data to be — 4527 cal. for the hydrate $ZnSO_4 . 7H_2O$, and hence, by adding the heat of hydration of this salt, the heat of solution of anhydrous $ZnSO_4$ in the solution $ZnSO_4 + 19·77\,H_2O$ is calculated to be 22,690 — 4527 = 18160 cal. The heat of precipitation of mercury from mercurous sulphate by zinc to form anhydrous zinc sulphate is 55,070 cal., and applying the formula given by Cohen [Abstract No. 2064 (1900)] the chemical energy of the cell is calculated to be—

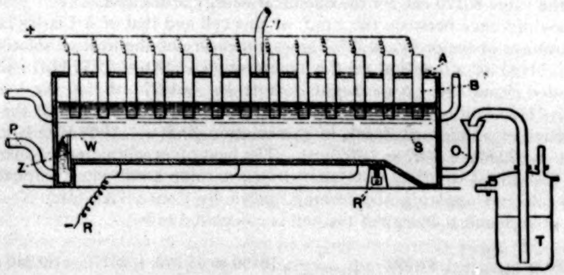
$$55{,}070 + \frac{19·77}{19·77 - 7}\,22{,}690 - \frac{7}{19·77 - 7}\,18160 = 55{,}070 + 25170 = 80{,}240 \text{ cal.}$$

This value agrees very closely with that deduced from the e.m.f. and temperature coefficient of the cell. T. M. L.

1362. *Depression of the Freezing-point in Solutions Containing Hydrochloric and Sulphuric Acids.* **J. Barnes.** (Roy. Soc. Canada, Trans. 6. pp. 37–54, 1900.)—The freezing-points of aqueous solutions of hydrochloric and sulphuric acids were determined with the aid of a Beckmann thermometer and reading microscope. The convergence-temperature of the apparatus was found to be 0·04° C. above that of the protection-bath, and the latter was therefore adjusted to 0·04° below the freezing-point of the solution. The solutions were cooled to 0·3° below the freezing-point by means of a freezing-bath of ice and salt-water at — 10° C., and were then transferred to the protection-bath; when the temperature had risen to within 0·1° of the freezing-point the freezing was started with a particle of ice and the temperature of the well-stirred solution noted. By this method a very high degree of accuracy was obtained; thus six determinations of the freezing-point of a solution of hydrochloric acid containing 0·104 gram-molecules per litre were obtained within the limits 2·3080° and 2·3086°, the freezing-point of water being 2·6782° on the same scale.

The ionisation coefficients of the simple solutions at 0° were determined from conductivity measurements at 0° and 18°, and for the mixtures were calculated by means of the formulæ of the author and of McGregor. The depressions of the freezing-point in mixtures of hydrochloric acid and sulphuric acids were then calculated and compared with the observed values; the differences were less than 0·002° in all but the two strongest solutions, and lie within the limits of error of experiment and calculation. The depressions of the freezing-point of mixtures of solutions of hydrochloric and sulphuric acids up to an average concentration of 0·2 gram-molecules per litre can therefore be calculated according to the dissociation theory on the assumption that the sulphuric acid dissociates into H, H and SO_4, and that the molecular depression of an electrolyte in a mixture is equal to its value in a simple solution of the same total concentration. T. M. L.

1363. *Solvay Electrolytic Alkali Cell.* **J. B. C. Kershaw.** (Electrician, 46. p. 789, March 15, 1901.)—This is an account of a new form of electrolytic cell for the production of chlorine from alkaline chlorides. The kathode consists of mercury and the anodes of carbon rods, or platinum. The essential features of this cell (Engl. Pat. Nos. 7470 and 7471, 1898) will be seen from the illustration. Contrary to most mercury cells, there is no mechanical movement of the whole cell; the amalgam formed being lighter is made to overflow into a well, partitioned off by means of an adjustable bridge (Z) and thence flows out through the pipe P into another cell, where it is decomposed by a reversal of current. The mercury is returned through the pressure vessel T into the cell through the funnel marked O, and the alkaline chloride solution is made to enter at B, thus passing over the mercury surface SW.



No figures as to efficiency are yet obtainable, but two installations of 1,500 h.p. each, in Belgium and Russia, producing 6,000 tons of alkali and bleach for each of these works, are in operation. O. J. S.

1364. *Soluble Alkaline Ferrates by Electrolysis.* **F. Haber.** (Écl. Électr. 26. pp. 453–456, March 23, 1901. Paper read before the Société Allemande d'Électrochimie.)—Potassium ferrate, K_2FeO_3, is obtained by fusing iron with potassium nitrate and also, as Poggendorf showed, by electrolysing a solution of caustic potash using an iron anode and an iron or platinum kathode. The author finds that cast iron is more effective than steel or wrought iron as the anode, and the yield is greater with soda than with potash; the electrolyte should be concentrated and heated to about 70°. Of the iron entering into solution, 62–74 per cent. is converted into ferrate, 2–14 per cent. is deposited on the kathode, and the remainder adheres to the anode. The dark red solution of the alkali ferrate obtained loses its colour on boiling, evolves oxygen, and then contains a *ferrite.* Much of the paper is of chemical interest only. N. L.

1365. *Motion of Ions in Chemical Reactions.* **O. Urbasch.** (Zeitschr. Elektrochem. 7. pp. 527–530, March 28, 1901.)—While experimenting on the influence of magnetic fields on the formation of electrolytic deposits of paramagnetic and diamagnetic metals formed in the fields, the author's attention was drawn to the motion of the electrolyte which took place in the field. The rotation of the electrolyte was so sensitive, even for very small currents, that the idea occurred to the author of using this rotation as an indication of the currents or ionic wanderings which take place in a solution during chemical reactions.

The present paper contains a summary of a number of chemical experiments conducted in a strong magnetic field, such as the dissolving of metals by acids, the deposition of metals from solutions of their salts by the introduction of other metals, the diffusion of two electrolytes, &c., in all of which the motion of the liquid was studied. The motion was perfectly regular in every case and reversed itself when the magnetic field was reversed. A complete explanation of all the phenomena is not yet forthcoming, but in the case of the solution of metals by acids Drude's explanation seems to apply, namely, that the ions moving with equal velocities in the magnetic field would be deflected in one or other direction according to their charge, and the ion having greatest friction would take the insulator with it. J. B. H.

REFERENCES.

1366. *A Theorem of van der Waals.* **P. Saurel.** (Journ. Phys. Chem. 5. pp. 137-140, Feb., 1901.)—Employing Gibbs' thermodynamical formulæ, the author proves that in a two-component univariant system the temperature will in general pass through a maximum or minimum, and that when the concentrations of two of the phases become equal the curve representing the relation between temperature and one of the variable concentrations will have a tangent almost perpendicular to the temperature axis. These theorems are both due to van der Waals, and have been experimentally verified by Roozeboom. F. G. D.

1367. *Combustion of Gases.* **S. Tanatar.** (Zeitschr. Phys. Chem. 36. pp. 225-226, Feb. 8, 1901.)—Continuation of the work referred to in Abstract No. 410 (1901).

1368. *Lecture Experiments in Physical Chemistry.* **A. A. Noyes** and **A. A. Blanchard.** (Zeitschr. Phys. Chem. 36. pp. 1-27, Jan. 22, 1901.)—A number of experiments are described with great detail. The subjects dealt with and the number of experiments are as follows :—Ionisation, 7 ; Velocity of Reactions, 4 ; Chemical Equilibrium of Dissociated Systems, 6. F. G. D.

1369. *Determination of Decomposition Voltages.* **W. D. Bancroft.** (Journ. Phys. Chem. 5. pp. 133-136, Feb., 1901.)—Description of apparatus, with results. W. R. C

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1370. *Engines for the Glasgow Electric Tramways.* (Engineering, 71. p. 141, Feb. 1; and pp. 173 and 176, Feb. 8, 1901.)—There are four engines in all. Two are made by the E. P. Allis Company, of Milwaukee, and were described in Abstract No. 2333 (1900), and the other two by Musgrave, of Bolton. The Musgrave engines are to exert 5,000 h.p. at full load, and 4,000 at normal load. There is one h.p. cylinder of 42 inches diameter, and two l.p. cylinders of 60 inches diameter. The steam pressure is 150 lbs. per square inch, the revolutions 75 per minute, the electrical output being 2,500 kilowatts. The bed-plate is in five pieces, and besides the usual bolts special bosses are provided, over which massive steel rings will be shrunk when the bed-plate is in position in Glasgow, so as to ensure the rigidity of the whole structure. Clearances have been reduced to a minimum, and projections are cast on the pistons to fill the cylinder ports. The valves are of the Corliss cylindrical type. There are two distinct ball governors, one only coming into operation if the main governor fails to act. A reheater, heated by live steam from the boiler, is fitted between the h.p. and l.p. cylinders. Jackets are fitted to the h.p. cylinders but not to the l.p. cylinders. The flywheel is of the ordinary type, and weighs 145 tons. L. S. R.

1371. *Continental Steam Engine Practice at the Paris Exhibition.* **W. D. Wansbrough.** (Cassier, 19. pp. 36–50, 1900, and pp. 387–403, March 1901.)—As regards horizontal engines, no case of an entirely overhanging cylinder occurs, and the end of the trunk guide is always supported. Some of the makers cast the main plummer block separate, which indicates that the casting in one piece would be too large for them to handle; this arrangement is not to be recommended, as should the bolts jointing the castings work slack, there is no possibility of tightening them up without lifting out the whole crank-shaft and flywheel. The flywheels are, generally speaking, too light for even and steady running. The various methods of construction are described and criticised. Several of the engines have a pad or semi-bearing to carry the weight of the piston and piston-rod and prevent the wear of the glands. The variety of design in the cross-heads of the various engines is a noticeable feature. The crank-pin ends of the connecting rods are generally of the solid end type, with adjustable wedge, or of the marine type. The valve gears are very numerous, but none are described in detail. Some ingenious devices for preventing the oil from splashing off the working parts are fitted and fully described. An account is given of several of the engines exhibited. L. S. R.

1372. *Corliss-Valve Engines and Gears.* **G. Windeler.** (Mech. Eng. 7. pp. 274–277, Feb. 23; 336–339, March 9; 378–379, March 16, and 424–426, March 23, 1901. Paper read before the British Institution of Draughtsmen) (Manchester Branch).—The tendency for larger units at slower speeds for large electrical work has led to the further development of the Corliss valve gear. The valves may be divided in three classes: (1) Valves at opposite corners. (2) Valves in covers. (3) Valves below cylinders.

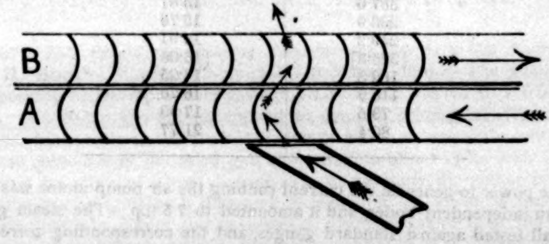
(1) The valves are so arranged in this class that any water finds its way immediately to the valves and so drains away. The valves are kept as near as possible to the cylinder, and clearances are reduced to a minimum.

(2) This class has the disadvantage that the drainage cannot be arranged for as in the previous type, but the clearances can be still further reduced.

(3) This arrangement is very compact, and lends itself particularly well to good drainage, but loss by initial condensation is greater.

A very large variety of arrangements of valves of different design, and placed in various positions in the cylinder and the covers are discussed and fully illustrated. The different forms of valves, governor gears, valve levers, wrist plates and rods, dash pots, &c., are fully described and their various merits discusssed, but the intricacies of their construction render it necessary to consult the original text for a proper comparison. L. S. R.

1373. *Seger Steam Turbine.* (Génie Civil, 38. pp. 313–315, March 9, 1901.) —Description of a turbine on the Laval principle, but having two discs



(A and B) which are rotated in opposite directions, the steam from the jet passing through both, as shown in the diagram. H. R. C.

1374. *Tests on a 300-H.P. Laval Steam Turbine.* **W. Jacobson.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 150–151, Feb. 2, 1901.)—The use of steam turbines has developed of late, due to the small space they occupy, and so they can be installed in existing factories where the space is limited without destroying or increasing existing buildings.

A 100-h.p. Laval steam turbine was installed in January, 1898, in some German paper mills, and the experience gained with this turbine was so satisfactory that it was decided to fit one of 300-h.p. The dynamo was made by Ganz & Co., of Budapest, and the turbine by the Actiebolaget de Lavals Angturbin, of Stockholm.

The turbine runs at 10,500 revolutions per min., and the gear wheels reduce to 750 per min. There is an independent air pump driven by an electrical motor. Steam is generated in a Dürr boiler, and passes through a Kausch superheater on its way to the turbine.

When developing 300 h.p., with steam at 132·3 lbs. pressure, and a vacuum of 26·3 inches of mercury, the turbine consumed 18·3 lbs. per h.p. hour.

With steam at 446° F. .... 17·2 lbs. per h.p. hour.
„ „ 572° F. .... 17·0 „ „ .

The steam for driving the feed pump was taken from another boiler, and the water that was collected from the main steam pipe was carefully weighed.

The following are the results of the trials :—

Length of test	5·133 hours.
Mean steam pressure in boiler	154·5 lbs.
„ „ temperature in superheater	415·6° F.
Temperature of steam due to 154·5 lbs. pressure	364.8° F.
Mean steam pressure after valve of governor	127·1 lbs.
Mean vacuum : inches of mercury	27
Mean reduced speed	754·66
Brake h.p.	342·1
Water per b.h.p. per hour	15·7 lbs.

The falling off in economy is well shown in the following table :—

B.H.P.	Water per B.H.P. per hour. lbs.
337·6	15·67
293·9	15·76
249·2	15·91
[226·3]	[16·00]
162·8	16·25
118·9	16·70
73·5	17·99
30·4	21·77

The power to generate the current running the air pump motor was taken from an independent boiler, and it amounted to 7·5 h.p. The steam gauges were all tested against standard gauges, and the corresponding corrections made in the pressures. L. S. R.

1375. *Use of Liquid Fuel in Locomotives.* **J. Holden.** (Mech. Eng. 7. pp. 544–547, April 20, 1901. Paper read before the International Railway Congress at Paris, 1900.)—Extensive trials carried out on the Great Eastern Railway resulted in the equipment of 58 locomotives with apparatus for burning oil-fuel, and the construction of storage plant consisting of underground tanks holding 50,000 gallons of oil, which they receive by gravity from travelling tanks brought by rail. Six cylindrical tanks holding 42,000 gallons, 20 feet above rail level, receive oil by means of a rotary pump and steam engine, and distribute it to locomotives by means of filling posts or arms like water cranes. A main line express engine can take in 600 gallons in from four to five minutes. Air pressure from the brake pump of the locomotive is also used at country depôts to effect delivery of the liquid fuel. Improvements were also effected in the burners used to spray the liquid, in the number and disposition of burners used, the regulation of air and steam, and other points.

A single Great Eastern Express locomotive has run 138 miles in 175 minutes, with one stop of four minutes, on a consumption of 190 gallons of tar residues (sp. gr. 1·1) equivalent to 14·4 lbs., of oil fuel per train-mile, with 6 cwts. of coal used to light the fire and raise steam = 5 lbs. per mile, or a total of 19·4 lbs. per mile. The same system has been adopted in Austria, France, and the Far East. The saving in carriage is a great inducement to the adoption of liquid fuel, one ton of it being equal in effect to two of coal. F. J. R.

GAS AND OIL ENGINES.

1376. 500 *H.P. Premier Gas Engine.* (Mech. Eng. 7. pp. 520–521, April 18, 1901.)—The engine has two motor cylinders arranged in tandem fashion, the pistons of which are connected by slide rods and crosshead. The front piston is of differential design and carries an enlarged end-piece in front, which works in a bored-out portion of the bed-plate, thus acting as a guide. Two side rods pass backwards from this end-piece on each side of the motor cylinder in passages cast in its casing, and by means of a crosshead connect with the projection of the back piston. Explosions take place alternately in the two cylinders. The space in which the large end-piece of the front piston works is used as an air-pump and a large volume of air is dealt with, enabling positive scavenging to be carried out to a satisfactory degree. Water-jacketing is applied to both valves and pistons.

Diagrams of indicator cards showing comparison of adiabatic and isothermal expansion, and others showing combined turning moments on the crank shaft and speed variations during one cycle, and also influence of inertia forces, are quoted from a paper on "Power gas and large gas engines," by H. A. Humphrey, in Trans. Inst. Mech. Engineers, Dec., 1900. F. J. R.

1377. *Late Practice in Utilising Blast-furnace Gas as a Gas Engine Fuel.* **W. H. Booth.** (Cassier, 19. pp. 341–348, March, 1901.)—The similarity in composition between producer gas and blast-furnace gas led to a trial of the latter in a 20-h.p. gas engine, applied to dynamo driving, at Wishaw Iron Works. In the author's test this installation gave 1 e.h.p. hour at the switchboard per 140 cubic feet of uncooled gas, equivalent to about 1½ lb. coal. In considering the action of a blast furnace as a gas producer, the author points out that the gas contains both dust and moisture; it has about 33 per cent. of combustible ingredients, and possesses an average heat value of 100 B.Th.U. per cubic foot. Purification is absolutely essential to its successful use in gas engines. The poverty of the gas in combustible elements is no drawback to its use in engines, because compression renders it easily inflammable even when at atmospheric pressure it would scarcely ignite. The proportions of the gas and air inlets of the engine must be suitably arranged.

Particulars of the Simplex engine of 700 h.p. and of the Oechelhaeuser gas engine at Hörde, are given, and reference is made to recent installations at the blast furnaces at Boulogne and at Sheepbridge, with the following analysis of the gases used at the two latter works :—

Blast furnace gas.	Boulogne.	Sheepbridge.
	Percentage by volume.	
Carbonic acid (CO_2)	10·0	9·0
Carbonic oxide (CO)	28·0	22·0
Marsh gas (CH_4)	—	1·4
Hydrogen	62·0	6·8
Nitrogen		59·8
	100·0	99·0
Water Vapour	2·4	—
Thermal value in B.Th.U. at 60° F. per cubic foot.	118	105

The Boulogne engine is of the twin-cylinder type, of 300 i.h.p., working on the Otto cycle. When developing 175 e.h.p. the consumption of gas was 145·2 cubic feet per e.h.p. hour or 99·6 cubic feet per i.h.p. hour; the overall efficiency being 68½ per cent.

Although the most obvious use of large gas engines in connection with blast furnaces is that of blowing engines for the furnaces, yet such engines are being installed for the generation of electric power and for the manufacture of electrolytic products. One pound of calcium carbide can be produced for 2·464 e.h.p. hours, using 308 cubic feet of gas of a net value of 100 B.Th.U. or a total of 30,800 heat units. To produce this volume of gas, 4·058 lbs. of coke would be required, assuming one ton to yield 170,000 cubic feet of gas. The coke, representing 54,978 B.Th.U., would be produced from 6·243 lbs. coal of 14,700 B.Th.U. per lb. or 91,772 B.Th.U. in all. Part of the difference in heat value between the coal and coke would be recovered in tar, creosote, and ammonia. The calcium carbide would yield 5 cubic feet of acetylene gas of a total of 240 c.p. hours and of 7,845 B.Th.U. calorific capacity, or 25 per cent. of the calorific capacity of the gas used in the engine.

If the 2·464 e.h.p. hours were used to work arc lamps, the result would be 2,464 c.p. hours or tenfold the light of the acetylene; whilst incandescent electric lamps would yield 384 c.p. hours.

The author directs attention to the disposition of air and gas power cylinders in blowing engines, and decides in favour of the four cylinder horizontal engines with vertical blowing cylinder, as against the tandem arrangement of the Seraing engine.

Some remarks on improvements in furnace tops, and on the volume of gas produced per ton of fuel in the blast furnace conclude the article. F. J. R.

1378. *Water Gas as compared with other Combustible Gases.* **J. Körting.** Zeitschr. Vereines Deutsch. Ing. 44. pp. 1301–1308, and 1345–1348, 1900.)—The gases at present used for power and lighting purposes are: *Producer Gas,* obtained by the incomplete combustion of fuel under the action of an air blast. *Dowson Gas,* obtained in the same way, when the blast contains steam. *Water Gas,* obtained by the action of a steam blast on glowing fuel; the fuel is maintained at a high temperature by an air blast, which is alternated with the steam blast. *Coal Gas,* obtained by the dry distillation of bituminous coal. *Carburetted Water-gas,* obtained by the addition of petroleum to water-gas.

The compositions of these gases are as follows:—

	Producer Gas.	Dowson Gas.	Water Gas.	Coal Gas.	Carburetted Water-Gas.
CO	23–30	23–27	40	6–8	23–28
CO_2	2–7	6–7	3–7	1–1·5	0·2–2·2
H	2–6	17–18	50	46–48	34–38
N	50–65	47–52	3–6		2·5–5
O	traces				
CH_4, &c.		0·5–2		34–38	17–21
C_2H_4, &c.				3–5	13–16
Specific Gravity	1·0	0·83	0·51	0·4	0·58–0·6
Calories per cub. m.	850–1,000	1,200–1,400	2,350–2,600	4,800–5,200	6,000
Temp. of flame, degrees C.	below 2,000°	below 2,000°	2,700°–2,800°	2,300°–2,400°	

Water-gas is especially suitable for the incandescent gas light on account of its high flame temperature; in a Welsbach burner, two litres per hour give one Hefner-candle, while 1·8 litres of coal gas (of twice the calorific value) are required for the same light. Producer and Dowson gas cannot be used in these burners. Water-gas, when in contact with iron, combines with it to form an iron carbonyl, which is deposited on the Welsbach mantle and quickly destroys it. When used for lighting, therefore, the iron gas-pipes must be protected by asphalting or galvanising.

The author then describes, with diagrams of the plant, the four principal methods of generating water-gas, namely, Fischer's, Humphrey and Glasgow's, Dellwik's [Abstract No. 897 (1900)], and the new method invented by Strache and installed by him in Pettau. Full details are given in each case of the consumption of coal and coke for heating and gas generating, and the efficiency of each process is worked out, and given as the ratio of the heat value of the fuel to that of the corresponding amount of gas. Similar details are also given for Dowson gas and for coal-gas, the figures referring to the latter being the average obtained from the statistics of two hundred installations for town supply. The figures are collected in the table below, the costs being reckoned on the assumption of the following prices of raw material and bye-products :—

100 kilos. steam coal	Marks	1·70
„ „ gas „	„	1·80
„ „ coke	„	2·00
„ „ tar	„	4·00
„ „ ammonia	„	18·00
„ „ benzoline	„	25·00
„ „ German gasoline	„	8·00
„ „ foreign „	„	14·00

The figures given in the table are the results of actual working, and not of experimental tests. All incidental losses are included in the consumption of fuel, and in the case of water-gas, the costs include the addition of carbylamin or other substance to give the gas an odour. Carburetting is carried far enough to bring the gas to 16-candle standard. Costs are given in pfennigs.

	Calories per cub. m.	Efficiency in per cent.	Cost of Fuel.		Cost of 1,000 candle-hours.	
			Per cub. m.	Per 1,000 calories	Batswing burner.	Welsbach burner.
Humphrey and Glasgow's Process.						
Pure water gas	2,500	55	1·77	0·71		3·54
Do. carburetted with German oil	5,000		4·00	0·80	37·5	7·4
„ „ „ foreign oil	5,000		6·2	1·24	57·0	11·0
Dellwik's process.						
Pure water gas	2,350	51	1·66	0·71		3·48
Do. carburetted with German oil	5,000		4·21	0·87	40	7·7
„ „ „ foreign oil	5,000		6·32	1·28	60	11·6
„ „ „ benzoline ...	3,700		4·62	1·24	44	8·5
Strache's process.						
Pure water gas	2,500	35	2·24	0·90		4·48
Do. carburetted with German oil	5,000		4·47	0·90	42	8·81
„ „ „ foreign oil	5,000		6·67	1·32	63	11·4
„ „ „ benzoline ...	3,700		5·20	1·40	49	9·4
Coal Gas.						
Without bye-products	5,000	33·5				
With „ „	5,000	66	1·9	0·38	17·8	3·4
Mixed Coal and Water Gas	3,670		2·35	0·64		4·25
Dowson Gas	1,250	70	0·51	0·44		

As regards the relative costs of plant, that for Dowson gas is by far the cheapest; for water-gas the cost is about four times as much, and for coal gas is slightly higher than for water-gas. The cost of labour is about the same in water-gas and coal-gas installations, while for Dowson gas it is somewhat lower.

The author concludes as follows:—For power purposes, Dowson gas is by far the best, being more efficient, simpler, and cheaper in cost of plant. For industrial purposes, where a high temperature is required, water gas has the advantage. For town lighting, carburetted water-gas can compete with coal gas only in very small installations, and where bye-products are unsaleable; it can, however, often be of advantage as an auxiliary plant to a coal-gas installation. G. H. B.

1379. *Mathot Indicator.* (Locomotion Automobile, 8. pp. 135–136, Feb. 28, 1901.)—A pressure indicator is described, designed by R. Mathot, applicable to high-speed petrol engines. It is identical in principle with the ordinary diagram indicator except that the "card" is a continuous strip of paper passed round the drum by means of clockwork. The piston of the indicator actuates a moving pencil, and a fixed pencil traces the line of atmospheric pressure. The cylinder of the indicator is water cooled. The diagram shows the number of explosions during any given number of revolutions, their pressure, and the pressure of compression when an explosion is missed. With a light spring the back pressure and partial vacuum on exhaust and suction are clearly shown. Some interesting diagrams from a "BG" motor at speeds up to 800 r.p.m. are given. C. R. D'E.

AUTOMOBILISM.[1]

1380. *Milwaukee Steam Truck.* (Horseless Age, 7. pp. 56–59, Feb. 6, 1901.)—The most noticeable feature of this truck is that it is fitted with solid rubber tyres, although the carrying capacity is 4,000 lbs. Its own weight is not given, but the tyres are 4 inches wide and are of that type in which blocks of rubber protrude from an inner cushion through spaces in a steel rim. The idea of the makers is that it is cheaper in the long run to renew the tyres when necessary than to subject the machinery to detrimental vibration, or to sacrifice the speed of the vehicle; they also consider that the road conditions are such in America as to render steel tyres troublesome. The truck is 11ft. 7½in. long by 6ft. 3in. wide, the platform for carrying the load is 8 feet long by 6 feet across, the wheel base is 6 feet, and the wheel track 4ft. 8½in. between tyre centres; it can turn in a circle of 29ft. 6in. diameter. The framing, reach bars, and other parts subject to excessive twisting strains, or working chiefly in compression, are all made of seasoned oak. The rear axle, which is an unbroken truss tube carrying the differential gear on sleeves, is supported in bearings both inside and outside the road wheels—four springs and reach bars holding them in place. The front axle is a steel forging which is embedded in oak on the compression side, and at the ends of which the axles of the steering wheels are pivoted. The two axles are connected by reach bars, and the rear axle is connected to the platform by long inclined radius bars, which are attached to the axle by eccentrics so as to allow of adjusting the driving chain. Wooden wheels are used. Plain bearings, with thrust collars where necessary, are employed throughout. A foot brake acts upon the differential gear box and a screw hand brake works equally upon both rear tyres. A horizontal wheel with a worm-gear serves for steering, and a block chain in lieu of rods allows a larger turning arc to be obtained. Water tanks with a capacity of 550 lbs. are placed above the driving axle, and a kerosene tank holding 170 lbs. of oil is fixed behind these ; this quantity of water serves for running about 20 miles, and of oil for 60 miles. A triple cylinder, single-acting vertical engine is fixed at the back of the driver's cab, partly above and partly below the platform. The valves are of the poppet type, and are operated by cams which allow of varying the cut-off in the cylinder and of reversing the engine. The cam shaft slides longitudinally in its bearings, and thus brings the different cams into operation as required. The lift of the valves is ⅛ inch. Power is transmitted from the engine to a countershaft by either of two sets of gears ; the one has a speed ratio of 4 to 1 and the other of 11 to 1. A positive clutch, which can only be moved when the engine is at rest, brings either of these gears into play, and gives a normal speed to the truck of either 10 or 4 miles an hour. The final drive, from the countershaft to the rear axle, is made by means of a central chain. The boiler is of the ordinary fire-tube type, with 150 square feet of heating surface and a normal working pressure of 225 lbs. per square inch. Two single nozzle burners, using "heavy kerosene," supply the necessary heat. Drawings of a similar truck, also designed by W. L. Bodman, accompany the description ; in these drawings the load is given as 3,000 lbs., the engine speed as 550 r.p.m., the two speeds as 12·8 and 5·1 miles per hour, and the fuel tank capacity as 22 gallons. A. G. N.

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[1] Electric Automobiles are described in the section dealing with Electric Traction.

1381. *The Hautier Petrol Car.* (Locomotion Automobile, 8. pp. 102–105, Feb. 14, 1901.)—This vehicle is fitted with motors of either 4½, 7, or 12 h.p., which are known by the name "Espérance." The peculiarity of the motor is that the combustion chamber is formed in two parts, and a valve is fitted in such a way that it can be made to close all communication between them when so desired while the motor is working. The object of this device is to more nearly approach the conditions of a variably timed ignition device while still using some form of tube ignition. At starting, and when the motor is running slowly, the valve above mentioned is allowed to remain open ; the size of the combustion chamber is then such that the degree of compression is somewhat less than that now normally employed in other motors. When the speed is increased, and an even higher speed is desired, the valve is closed, and, the compression being thus considerably increased, ignition occurs earlier. Another feature of this motor is the exhaust valve gear, in which a specially shaped cam causes a lever to rock backwards and forwards about the axis of a spindle to which it is fixed. The movement of the lever alternately opens each of the exhaust valves, and the degree to which they are lifted is variable. The general arrangement of the propelling mechanism is similar to that of Darracq [see Abstract No. 555 (1901)], and many others, but the change-gear wheels remain always in mesh, and an epicyclic train replaces the ordinary clutch, between the motor and the gear case ; the last-mentioned device has one of its members mounted so as to revolve freely normally, and a band brake is used to retard it progressively and to hold it ultimately—thus establishing a rigid connection between the motor and the gearing gradually. Several illustrations accompany the description.

A. G. N.

1382. *Municipal Motor Vans.* (Automotor Journal, 5. pp. 236–237, Feb., 1901.)—In a report made by the surveyor to the city borough of Westminster the following information is given concerning a Thornycroft steam waggon which has been in use in the Strand district. For the first eight weeks the motor was on hire from the makers at a total cost, including fuel and labour, of £7 10s. per week. During this time it was used for dust collection only, and it dealt with 152 loads, comprising over 252 tons. The vehicle was then purchased, and two bodies (tipping and watering) were supplied with it. During the following seven weeks 153 loads, weighing nearly 364 tons, were removed by it, and its consumption of Nixon's navigation coal was 9 tons. In an ensuing period of seven weeks it was also used for street watering, the body being changed each day and night. During this time it collected 87 loads of dust, of a weight of 189 tons, it distributed 225 loads of water (157,500 gallons) in the daytime, and 777 loads (543,000 gallons) for flooding the streets at night. The coal consumption in this third period of working was 12 tons. It is pointed out that house dust is very light, and that its weight does not convey a correct idea of the labour involved in its collection; the yearly average for the Strand district, exclusive of street or market sweepings, is 1,265 tons per mile of street, whilst the bulk is 4,216 cubic yards. For this reason, and because experience has shown the especial economy of steam power for the heavier traffic, the use of a trailer is strongly urged for dust waggons. Concerning the relative cost of working during the above-mentioned periods, an estimate of the annual saving which would be effected by the employment of this machine is given in detail, and amounts to £772. A further estimate of the annual expenditure necessary in respect of the motor places this amount at £598 8s. A. G. N.

1383. *Metropolitan Motor Manufacturing Co.'s Voiturette.* (Automotor Journal, 5. pp. 260–261, March, 1901.)—A two-seated carriage in which the body, the motor, and the speed-gearing are carried by an angle-iron rectangular frame, which is itself suspended upon the front steering-wheel axle and the "live" driving axle by semi-elliptical springs. Ackermann steering is used, and the rear axle runs in Mossberg roller-bearings. The motor is placed across the front of the frame; it consists of two separate vertical cylinders 3½-inch bore by 6-inch stroke, which are each provided with a crank chamber containing an overhung crank-pin on the end of a short projecting crank-shaft. The two crank-shafts are coupled together, and carry a central flywheel with a pulley on either side of it. A cam-shaft mounted above the cylinders is driven by bevel gearing, and operates the two exhaust valves and the contact breakers for the ignition device. The cylinder covers, which are easily removed, contain the inlet and exhaust valves, as also the ignition plugs and compression relief cocks. A counter-shaft is provided across the centre of the frame, and carries a rocking gear-case which encloses two opposite and eccentrically mounted pinions and concentric intermeshing spur wheels. Each of the short shafts carrying the pinions projects from the gear-case, one on each side, and each of them is fitted with a pulley. A pair of 2¼-inch belts connect these pulleys with those upon the motor shaft, and both the belts are normally slack. By rocking the gear case about the countershaft either belt can be tightened, and the power from the motor can thus be transmitted to the countershaft by either pinion. The two pinions are of different diameters, and thus either of two speeds can be obtained. A chain connects the counter-shaft with a differential gear on the rear axle.

A. G. N.

1384. *Heavy Motor Traffic in France.* (Horseless Age, 7. pp. 26–29, Dec. 26, 1900, and 26–28, Jan. 2, 1901. Abstract of a paper read before the Liverpool Self-propelled Traffic Association by **G. Forestier.**)—A review of the progress of motor vehicles for passenger and for goods transport in France since the "Poids lourds" trials of 1897. Dealing firstly with passenger vehicles, the author points out the general tendency towards increase of power per person carried in order to secure a high commercial speed and greater number of journeys per day. For example, the de Dion and Bouton steam omnibus, in the 1897 trials, with a weight of 5 tons empty and 6·7 tons carrying 16 passengers, had an average speed of 8·6 miles per hour. In the 1900 trials, a vehicle of the same construction weighed 6·6 tons empty, 8·6 tons carrying 20 passengers, and had an average speed of 11·2 miles per hour. The estimated cost per traveller per mile with luggage, ten persons being reckoned to the ton, has diminished as follows :—

In 1897	0·48d.
In 1898	0·24d.
In 1899	0·23d.

These calculations do not, however, make any allowance for damage done to the roads. Passenger vehicles propelled by internal combustion engines possess certain advantages over steam-propelled vehicles, but owing to the power of the engine being practically constant, any increase in the tractive resistance has to be met by decreasing the speed of the vehicle. The fact that only one person is required to drive and control the vehicle reduces the working expenses, but cost of fuel is much greater than with steam power. Taking the cost of coke at 29s. 6d. per ton and petrol at 1s. 6d. per gallon, the results of the trials at Versailles work out 0·91d. per net ton-mile for fuel with a coke-fired boiler and 3·15d. with a petrol engine.

Electrically propelled vehicles have competed in the "Poids lourds" trials since 1898 with some success, and have been in practical use in Paris, but in most cases the useful load forms a very small proportion of the total weight, and the distance that can be travelled per charge is small. The supply of current to electrical vehicles from a motor trolley travelling on an overhead cable promises a solution of the difficulty in certain cases [see Abstract No. 588 (1901)].

With regard to vehicles for the delivery of goods the figures given in the following table have been deduced from the "Poids lourds" trials :—

Date.	Maker.	Type.	Freight.	Total Weight.	I.H.P.	Speed.
			Tons.	Tons.		Miles per hr.
1897	Scotte	Lorry, with single trailer	4·1	11·6	16	4·0
1898	De Dion & Bouton	Lorry	3·2	8·7	30	7·1
1899	Ditto	Ditto	3·9	9·7	30	9·2
1900	Ditto	Ditto	2·3	7·5	28	8·2

As in the case of passenger vehicles, the weights and speeds are such that the damage done to the road surfaces must be considerable. The author points out that as the carrying capacity with a given engine power decreases with increased speed, the net ton-miles per day will be very considerably reduced if the speed is excessive, and the wear and tear on vehicle and road much increased, so that for the most economical working, moderate speeds must be maintained.

For the transport of moderate loads the petrol lorries of de Dietrich and others have given very good results. Particulars of some of these vehicles are given in the following table :—

Date.	Maker.	Type.	Freight.	Total Weight.	I.H.P.	Speed.
			Tons.	Tons.		Miles per hour.
1897	De Dietrich	Lorry.	1·2	2·5	6·5	5.3
1898	Ditto	Ditto	1·5	3·3	9·0	6·7
1899	Ditto	Ditto	2·3	4·1	9·0	6·6
1900	Ditto	Ditto	3·0	4·8	9·0	7·6
1900	Panhard and Levassor	Ditto[1]	2·0	4·4	8·0	7·4
1900	Peugeot	Ditto[2]	1·2	2·4	8·0	8·3

[1] Solid rubber tires on steering wheels.

[2] Solid rubber tires on all wheels.

An interesting electrically propelled lorry has recently been built for the Say sugar refinery of Paris; it weighs with accumulators, but unladen, 11·8 tons, and carries a load of 10 tons. The motor is rated at 20 h.p., and at the Vincennes trials of 1900 the average speed was 3·3 miles per hour, and 2·0 m.p.h. up an incline of 10 per cent., the motor then taking 200 amps. at 155 volts. With regard to cost of working, the author considers that the usual rating of 10 per cent. to 15 per cent. of the prime cost for maintenance and repairs is too low, and that 25 per cent. would be a safer estimate for practical working. The following results have been deduced from the "Poids lourds" trials :—

COST PER PASSENGER MILE, INCLUDING LUGGAGE, OR PER TWO CWTS. OF PARCELS PER MILE. (In decimals of One Penny.)

	Third-load.	Half-load.	Fully Laden.
STEAM.			
De Dion and Bouton omnibus—			
1900 .... 22 seats	0·46	0·24	0·14
De Dion and Bouton brake—			
1897 .... 35 seats	0·67	0·34	0·23
1898 .... 55 „	0·43	0·22	0·15
Serpollet omnibus—			
1898 .... 14 seats	0·93	0·50	0·34
Scotte omnibus—			
1897 .... 26 seats	1·10	0·57	0·39
GASOLINE.			
Panhard and Levassor omnibus—			
1900 .... 14 seats	0·90	0·46	0·34
Rozer-Mazurier omnibus—			
1898 .... 14 seats	1·05	0·52	0·37
De Dietrich brake—			
1898 .... 10 seats	1·06	0·49	0·34
1899 .... 10 „	0·78	0·42	0·30

GOODS—COST PER NET TON-MILE. (In Pence.)

	Third-load.	Half-load.	Fully Laden.
STEAM.			
Scotte train (1897)	9·29	4·82	3·36
De Dion and Bouton lorry—1900	4·09	2·18	1·52
GASOLINE.			
De Dietrich lorry—1900	6·13	3·42	2·49
Panhard and Levassor lorry (1900)	6·39	3·65	2·64
Peugeot lorry (1900)	6·98	3·95	2·93

In conclusion, the author compares the cost of motor transport in France with the cost by railway and by horse; and calls attention to the chief items in the road maintenance question. C. R. D'E.

1385. *Collin's Electric Vehicle Company's Steering Gear.* (Locomotion Automobile, 8. pp. 137–138, Feb. 28, 1901.)—This article describes a form of steering gear which combines the old locking-plate method of steering by turning the front axle, with the usual form of pivoted axles for the steering-wheels. The construction is very complicated, but possesses the features that a very small movement of the hand suffices for describing curves of small radius, and that the controlling action is irreversible.

C. R. D'E.

1386. *Diameter of Wheels for Autocars.* **W. A. T. Müller.** (Centralblatt Accumulatoren, 2. pp. 89–93, March 15, and 105–108, April 1, 1901.)—This article, which is mainly of an elementary mathematical nature, continues the discussion of the question already dealt with by Luxenberg. [See Abstract No. 587 (1901).] The author starts by considering the formula $P = Q\frac{f}{r}$, where P is the tractive force on the vehicle, Q is the load, r is the radius of the wheel, and f is the so-called leverage of rolling friction. This latter quantity may be defined as the horizontal distance between the resultant vertical pressure exerted by the ground on the wheel and the vertical through the centre of the wheel. Luxenberg treats f as though it were constant, and independent of the size of the wheel; Müller, however, considers that this is not the case, and that f increases with the radius of the wheel. The author deals in his article with the case of a vehicle having rigid wheels, which roll on an elastic roadway; and he assumes that the pressure at any point on that part of the surface of the tyre which is in contact with the roadway is proportional to the depth of the depression caused at that point. He then shows that the resistance due to rolling friction is proportional to the square of the depth of the depression caused on an elastic roadway, and arrives ultimately at the following formula, viz.—

$$W = c\sqrt[3]{\frac{Q^4}{br^2}}$$

where W is the resistance due to rolling friction, Q is the load, b is the breadth of the tyre, *r* is the radius of the wheel, and *c* is a constant depending on the nature of the roadway and the material of which the tyre is made. Hence for a given load W is inversely proportional to $\sqrt[3]{r^2}$, whereas Luxenberg states that it is inversely proportional to *r*, and Zechlin says it is inversely proportional to $\sqrt{r}$. The author concludes with a few numerical examples, and considers that if accumulator traction on ordinary roads without rails is to be a commercial possibility, a type of car will have to be designed on lines altogether different from those on which omnibuses and such-like vehicles have been constructed in the past. He speaks of wheels having a diameter of 2·5 m., and with these he thinks that it is possible to attain an efficiency represented by 50 watt-hours per ton-kilometer. W. H. S.

REFERENCES.

1387. *Theory of Heat-Engines.* **A. Witz.** (International Physical Congress at Paris, Report, 3. pp. 296–305, 1900.)—A short account of recent *experimental* theories of the steam-engine, including the work of Boulvin and of Nadal, is given, and the need of similar work for the more complex case of gas-engines is urged. R. E. B.

1388. *Double-Tube Boiler.* **J. Irving.** (Engineering, 71. pp. 474–475, April 12, 1901. Paper read before the Institution of Naval Architects.)—This is a description of a horizontal water-tube boiler with concentric fire tubes, which gave fairly good results on trial. F. J. R.

1389. *Thornycroft-Marshall Water-Tube Boiler.* (Mech. Eng. 7. pp. 550–553, April 20, 1901.)—A description of this form of horizontally inclined water-tube boiler in both "non-sectional" and "sectional" designs with illustrations, and photographs showing the method of constructing a non-sectional boiler.

GENERAL ELECTRICAL ENGINEERING.

1390. *New Primary Batteries.* **A. Reynier.** (Électricien, 21. pp. 86–89, Feb. 9, 1901.)—Two cells, due to Fontaine-Atgier, are described. One is a simple element, consisting of iron and zinc in caustic soda solution; the depolarisation, which appears to be efficient, is mechanical, and is effected by having the iron in the form of gauze. The e.m.f. is about 0·45 volt. The other cell is of the two-fluid type, consisting of zinc in caustic soda separated by a porous pot from carbon in a nitric depolarising solution (of secret composition). The e.m.f. may be as high as 2·5 volts, and the depolarisation is good. The porous pots are made of perforated ebonite or celluloid surrounded by pasteboard. W. R. C.

1391. *Utilisation of Lead Slime and Old Plates.* **E. Levermann.** (Centralblatt Accumulatoren, 2 pp. 53–54, Feb. 15, 1901.)—Lead slime—a mixture of lead peroxide, lead sulphate, and sulphuric acid—is best treated by washing with water to remove acid, decomposing the lead sulphate with soda, removing the lead carbonate thus formed by washing with acetic acid, and drying the residue at 180°. The lead peroxide thus obtained may be used for such purposes as match-making, &c., where absolute purity is not essential. Old plates may be sent direct to the smelting works, but it is sometimes better to separate the active material, which may be either smelted or used for forming new plates, and to recast the grids. N. L.

1392. *Meters of the Allgemeine Elektrizitäts Gesellschaft.* **M. Aliamet.** (Électricien, 21. pp. 81–86, Feb. 9, 1901.)—Two meters are described with numerous illustrations. The first, for continuous currents only, consists of an electro-dynamometer, the main current passing through the fixed coil and the shunt current through the moving coil; the latter is caused to oscillate between fixed limits by an automatic commutator; the rate of oscillation is directly proportional to the power, and the number of oscillations is registered by a ratchet acting on an indicating train. The commutator consists of four contacts, two in a double-magnet relay, and two actuated by the moving coil. The shunt current passes through one relay magnet, two resistances, and then the second relay magnet; the terminals of the moving coil are attached, one between the two resistances and the other to the two contact fingers. The current passes in parallel through the moving coil and one or other of the resistances, according to which contact is made by the relay, the direction of current being different in the two cases; the relay is thrown over by the moving coil, at the end of its throw, making a contact which short-circuits the relay magnet and the resistance; this demagnetises one relay magnet and increases the current in the other, which then pulls over the relay contact; this process is repeated alternately in each direction. The meter starts with 1 per cent. of its maximum current. The shunt circuit absorbs 1·2 watts at 100 volts. Readings are correct at 90 per cent. load and 6 per cent. load, with an intermediate maximum error of 1½ per cent.; at 2 per cent. load the error is 1½ per cent. in the opposite direction.

In the second meter, for alternate currents only, three electromagnets,

with a common yoke, act on one side of a copper disc, the magnetic circuit above the disc being completed by an iron bar facing the three poles. The shunt current traverses the first and third magnets; if the iron bar be inclined, so that the air gap of one magnet is greater than that of the other, rotation of the disc will ensue, owing to inequality in the two induced currents. This fact is employed as a means of compensating internal friction, the inclination of the iron bar being adjusted till the meter just does not run on the shunt circuit alone. The main current traverses the first and second magnets, this second magnet serving as compensator for the want of proportionality between magnetic flux and current. The meter does not read correctly on an inductive load. On a non-inductive load the error does not exceed 1 per cent. down to 5 per cent. of maximum load. The starting current is 1 per cent. of the maximum, and the power absorbed is 1 watt in the shunt circuit and 2 watts in the main circuit at full load.
G. H. B.

1393. *Raymond's Automatic Time Switch.* **G. Dary.** (Électricien, 21. pp. 161–162, March 16, 1901.)—In this apparatus, there is a crown-wheel driven by a clock, and on this wheel are secured two curved arms which can be clamped thereto by means of a lock-nut so as to project from the side of the wheel at any desired angle apart. These arms drive a star-wheel on an arbor bearing a second star-wheel of insulating material. This second star-wheel has a metal plate secured on one or more of its faces and connected through a fixed spring contact to one end of the interrupted circuit. The other end of the circuit is connected to a contact piece mounted on a spring, which presses it against the star-wheel. By this means the circuit can be made and broken for any desired period or periods in the twenty-four hours. This apparatus is in use for controlling the illumination of advertisement kiosks at Lyons and Saint-Étienne. C. K. F.

1394. *"Armacell" Insulating Varnish.* (Elect. Engin. 27. pp. 190–191, Feb. 8, 1901.)—A varnish must be (1) insulating; (2) must not soften with heat; (3) not fall off in insulation with heat; (4) be flexible; (5) adherent to all materials used in electrical construction. Results are given of tests of paper coated with "Armacell." M. O'G.

1395. *Cleanliness of Porcelain Insulators.* **G. Pierard.** (Soc. Belge Élect., Bull. 18. pp. 71–72, Feb., 1901.)—After use, a number of insulators were cleaned and tested in comparison with the dirty ones; with deep petticoats the falling off was from 4,400 to 3,400 megohms. Small insulators fell off from 6,800 to 1,800 megohms. M. O'G.

1396. *Siemens and Halske High-Tension Safety Device.* **H. Görges.** (Elektrotechn. Zeitschr. 22. pp. 310–311; Discussion, p. 311, April 4, 1901. Paper read before the Elektrotechn. Verein, Dec. 18, 1900.)—This paper describes a device of the spark-gap type, intended to prevent accidental shocks arising from defective insulation in transformers and such apparatus. It consists essentially of a plug and socket, the plug containing two metallic portions, which are separated from one another by a thin sheet of mica, pierced with holes. By inserting the plug in the socket the necessary contacts are made, and if the voltage rises to a dangerous degree, the discharge passes through the holes in the mica sheet. The discussion seemed to show that the device (of which a drawing is given) is at present rather uncertain in its action.
W. H. S.

1397. *Starting Resistances for Motors.* **P. Bunet.** (Ind. Élect. 10. pp. 103–107, March 10, 1901.)—Assume that the resistance is to allow a current I to flow when the switch is on the first contact, and that after the current has fallen to i the switch is moved to the second contact, when the current is to rise to I again, and so on. Then, if R is the resistance of the motor, and

$R_1 = R +$ resistance of starter on first contact,
and $V =$ voltage of mains,
then $I/i = R_1/R_2 = R_2/R_3 =$ &c.
Thus $R_1/R = (I/i)^{n-1}$, n being the number of contacts.

$$\text{Or, since } R_1 = V/I,\ n = \frac{\log V/I - \log R}{\log I/i} + 1.$$

The writer shows that, in cases where the torque opposing the motor is independent of the speed, the times during which the switch is left on successive contacts in starting should, like the resistances, decrease in geometrical progression. In automatic starters the contacts may be made of decreasing width to secure the above condition. Various numerical cases are given.

For a resistance made of round wire it is proved that the volume is proportional to the cube root of the specific resistance of the metal used, assuming that heat emissivity and final temperature are the same in each case. On the other hand, if the current is only allowed to pass for a short time, the heat generated being assumed to be all taken up by the wire, then the volume is independent of the specific resistance. W. H. E.

1398. *Electric Travelling Cranes.* **A. Kolben.** (Elektrotechn. Zeitschr. 22. pp. 148–154, Feb. 14, 1901.)—In all the latest cranes there are three separate motors, one for each motion. They are mostly four-pole direct current, or else induction motors. Worm gearing is used for reduction from the motor speed, and in some cases is combined with toothed gearing. For taking up the axial pressure of the worm, collars with ball bearings are employed. The usual pitch-surface velocity of the worm is from 5 to 6½ metres per second. The worm wheel consists of a phosphor-bronze toothed ring mounted on a steel casting; the worm is of hardened steel. A brake is required for the lifting drum and, in quickly-moving cranes, on the traveller also. The weighted brake is held off by the pull of a solenoid, the plunger of which may be designed so as to leave a partial vacuum below it when raised, thus overcoming residual magnetism when the current is switched off. An emergency brake is worked by the driver's foot; and the worm gearing, by its non-reversibility, is an additional safeguard. The paper, which is well illustrated, deals specially with cranes made by the Elektricitäts Act. Gesellschaft, formerly Kolben & Co., of Prag-Vysocan. W. H. E.

1399. *Electric Cranes.* **P. Uellner.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 289–297, March 2, 1901.)—A description is given of several cranes recently made by the Compagnie Internationale d'Électricité. A traveller for an ironworks has a span of 13 metres, and the following speeds: for a load of 22 tons, 2·5 metres per minute; for 2 tons, 20; for the crab, 25 to 30; for the crane, 80 to 90. A separate motor is provided for the 22-ton hook and the 2-ton. The motor for the crab is 6 h.p., and the three others are 15 h.p. each, with a speed of 950 r.p.m. Toothed gearing is used throughout, the speeds being high enough to render this convenient instead of worm gearing.

The leather pinion of the motor drives a cast-iron wheel engaging a wrought-steel pinion geared with a cast-steel wheel; for the 22-ton hook there is an additional pinion and wheel. The speed ratio for each pair is 4 or 5 to 1. The 2-ton hook, on account of its speed, is controlled by a specially powerful electric brake, and great care had to be taken in designing the guides for the quickly moving chain. Tests of the crane gave the following results for the four motions :—

	Load (tons).	Speed. m./min.	E.H.P.	Efficiency per cent.
Large hook	0	2·3	6·7	—
	23	2	16	64
Small hook	0	26	7·35	—
	2	20	12·7	70
Crane	0	96	9·7	—
	23	60	16·8	—
Crab	0	32·5	2·9	—
	23	28·5	6·7	—

The tractive force required for the crane was 25·5 kg. per ton, and for the crab 24.

In another travelling crane a special arrangement is used to enable the load to be raised exactly vertically by means of one rope wound on one drum. The upper block of the lifting tackle swivels on ball bearings so as to be always in the same plane as the rope which winds on or off the drum. The pulleys in the lower block must have a radius greater than half the length of the drum. A wire rope is used, 14·5 mm. in diameter, and having a breaking load of 6,050 kg. With four ropes in the tackle the factor of safety is 6.

The efficiency at full load of 4 tons, raised 4 m. per minute, is 71 %.

In this traveller all three motors are provided with electric brakes, which come into action on switching off the current, and thus facilitate accurate placing of the load.

The paper also gives a description, with drawings, of some powerful cranes supplied for handling blocks of stone in quarries. Each consists of a lattice-work girder fixed on trestles which run on rails; and a lifting crab travels over the length of the girder. The largest one can lift 60 tons.

W. H. E.

1400. *Electricity in Machine Shops.* **F. R. Jones.** (Engineering, 71. pp. 287–288, March 1, and 320–321, March 8, 1901. Paper read before the Amer. Soc. Mech. Engineers.)—After discussing the conditions to be fulfilled, the author decides in favour of direct-current supply at 220 and 110 volts on the three-wire system as most suitable for power and lighting. Experiments showed that two lathes, when polishing columns 10 and 12 inches diameter. together required 7 h.p.; two planers, with tables 6 feet and 10 feet wide, driven by one motor, took up to 60 h.p. when both were reversing at once; a planer, with a table 5 feet wide, took 25 amperes when cutting, and 45 amperes when reversing, at 230 volts; three 30-ton four-motor cranes took up to 100 h.p. each as a maximum when all the motions happened to be in operation simultaneously. Full details of the results of these and other tests are given. The conclusion is that three independent circuits are necessary—a crane circuit, for the most irregular loads; a machine-tool circuit for the steadier loads; and a lighting circuit.

Two large generating sets for the power circuits, and a smaller one for lighting, are recommended, and a motor generator for balancing. The author advocates the use of pneumatic hoists and electric locomotives for handling materials in the works and yards. Experiments made in two large works before the adoption of electric driving showed that half the average power of the engines was wasted on friction. The paper concludes with a strong argument in favour of portable tools driven by electric motors, mainly based on the saving of time in setting the work in position. A. H. A.

1401. *Electric Power in Workshops.* (Frank. Instit., Journ. 151. pp. 1–28 (Jan. 1901; Discussion.)—**F. B. Crocker,** in opening a discussion on this subject, stated the advantages of electric driving under the following heads: (i.) *Saving of Power.* This is considerable, but relatively unimportant, the total cost of power in factories being only 1 to 3 per cent. of the total expense. (ii.) *Cheaper Buildings,* because lighter owing to absence of overhead shafting. (iii.) *Smaller Depreciation.* (iv.) *Flexibility* as regards arrangement of machines conveniently, and extensions. (v.) *Clear Head-room,* permitting overhead travellers anywhere. (vi.) *Cleanliness.* (vii.) *Healthiness.* In the Government printing offices in Washington, one of the largest in the world, the sick list decreased 20 to 40 per cent. after introduction of electric driving. (viii.) *Shut-downs less serious and less frequent.* (ix.) *Speed Control.* (x.) *Increased Output,* chiefly owing to advantages (v.) and (ix.).

S. M. Vauclain, superintendent of the Baldwin Locomotive Works, stated that "if we should abandon electric driving, our manufactured product would now cost from 20 to 25 per cent. more for labour," and that "were it not for electric driving the Baldwin Locomotive Works would have to cover 40 per cent. more floor space than they now do, to maintain their present output."

G. S. Dunn stated that on the assumption of constant torque and capacity limited by commutation, the limits of successful speed control through the agency of the motor's field are at the extremes of a range of about 33 per cent. increase above a minimum speed. This requires a motor of which the capacity calculated at minimum speed would be about 33⅓ per cent. greater than the h.p. demanded at maximum speed, or about 76 per cent. greater than the h.p. demanded at minimum speed. A given motor, of which the normal speed is the minimum desired, must not be called upon at maximum speed for an output greater than its normal capacity multiplied by the ratio of the minimum speed to the maximum. The speaker referred to the "multiple voltage" and "Ward-Leonard" systems of speed control. The drawback to the latter is high first cost, but maintenance is low.

W. H. Tapley, of the Government Printing Offices, gave data concerning their motor plant during the past five years. The generating station contains three units aggregating 612 kw., and there are 200 motors totalling 854 h.p., as well as 5,000 16-c.p. lamps and an average of 70 amps. used in heating 10 press-heads. The average demand is 1,500 amps. at 120 volts, and the ratio of maximum demand to h.p. connected is 1 : 3·5 under average conditions. The saving on coal and gas bills was a clear 10 per cent. after allowing 6¾ per cent. on cost of plant for insurance, taxes, and interest. The increase in production for presses was 10 per cent.

C. Hering advocated the use of the multiphase induction motor for workshops. It is easily started at full load (the larger ones requiring for this purpose some simple slide-rings); it runs at nearly constant speed and stands considerable overload. No satisfactory method is yet known for varying its speed without impairing its efficiency. It is smaller, lighter, simpler, and cheaper for the same output and speed than the continuous-current motor.

G. S. Dunn differed absolutely from the last speaker. Ordinary constant-speed induction motors of the kinds built in America do not develop at starting more than from 1½ to 2·2 times their normal running torque, whereas direct-current motors will easily develop in starting from 4 to 6 times their normal running torque. Recent American quotations from companies making both classes of motors have been about 25 per cent. higher for alternating-current motors. The wear at commutators is now very slight ($\frac{1}{64}$ inch of commutator and ⅜ inch of carbon brush per annum). The extremely small air-gaps of induction motors necessary for keeping down wattless current causes serious trouble by accumulation of dust. The induction motor requires an enormous starting current, and its torque varies as the square of the voltage; consequently the starting up of one motor may reduce the torque of another motor sufficiently to make it lose its grip and stop. For this reason induction motors are being thrown out of a colliery.

C. Hering concluded from the last speaker's remarks that induction motors are more developed in Europe than in the United States. His remarks as to relative costs, weights, &c., were based on statements of a German company manufacturing both direct-current and induction motors. The cosine of the angle of lag of their motors is over 0.9, and the wattless current is therefore small. They will stand 200 per cent. overload, and will still give their normal output for two-thirds the normal voltage. The starting current can be kept down to the normal. E. H. C.-H.

1402. *Electric Power in Factories.* **W. Geipel.** (Elect. Rev. 48. pp. 340–342, Feb. 22, and 381–383, March 1, 1901 Paper read before the Gloucester Engineering Society, Feb. 19, 1901.)—Older methods fall under three heads—(i) Works driven by one large engine with shafting; (ii) works driven by scattered engines supplied from central bank of boilers; (iii) works driven by scattered engines and boilers.

In class (i), the engine should already be of the compound condensing type and efficient, but the losses in shafting are rarely as low as 20 per cent. At the Bristol Waggon Works the loss varied between 22 and 57 per cent. At the Hartlepool Engine Works, Middlesbrough, it ranged from 75·6 per cent. to 42 per cent. In the U.S.A., C. H. Benjamin made exhaustive tests on shafting losses in various factories, and his figures vary between 14 and 81 per cent. He found that the average h.p. lost per bearing was 0·5 h.p., per 100 feet of shafting 6 h.p., per 100 lbs. of shafting 0·25 h.p., and per belt 0·4 h.p.

In class (ii), steam may be economically generated by a central bank of boilers, but it is transmitted through long lengths of pipe to small uneconomical engines. The loss from condensation in steam-pipes amounts to ½ ton of coal per annum per square foot of uncovered pipe, if continually under steam and exposed to the atmosphere; with the best lagging this figure becomes ⅙th ton per annum. Small scattered engines are usually low-pressure, non-condensing. Bryan Donkin tested 100 such engines taken at random, and found the average consumption to be 150 lbs. of steam per i.h.p. per hour. T. Richardson found the average for 31 engines in his Hartlepool Works to be 51 lbs. per i.h.p. per hour.

Class (iii) is obviously expensive as regards coal bill and labour.

With electric driving the losses may be taken as follows: Motors, 8 per cent. (100 h.p. size) to 25 per cent. (¼ h.p. size); generators, 8 per cent.; conductors, 2 per cent., giving a total efficiency of 76 per cent. Allowing 10 per cent. for engine friction, we thus have 68 per cent. of the engine i.h.p. at full load delivered to the motor-shaft, or about 60 per cent. at half load. The introduction of electric driving has been found to increase the output of the works by about 20 per cent., and the facilities for dealing with heavy material are much greater. E. H. C.-H.

1403. *Electrically Driven Machine Tools.* **G. Ralph.** (Inst. Elect. Engin., Journ. 30. pp. 545–560; Discussion, pp. 560–566, April, 1901.)—The author discusses the advantages of electrically driven machine tools. He found that 100 feet of 2½-inch shafting running at 150 revs., to which 24 machines were belted, took to drive it light 45 per cent. of the power necessary when all the machines were in use. In another case of a works with four floors the loss was 56 per cent. In six American shops the average loss was 62 per cent., and in one the loss was 80 per cent. The total h.p. of motors may be double the h.p. of the power station. In the Baldwin Locomotive Works 1,300 h.p. serves 3,100 h.p. of motors. The power required by machine tools is often underestimated by the makers. A grinding machine for trueing up the edges of armour plates, which the makers said would take 6 h.p., was found to take 35 or 40 and occasionally 60. A slab milling machine, which the makers said would take 6 h.p. for a specified depth of cut and rate of feed, actually took nearer 15. This machine eventually had two motors fitted, one to drive the cutter, and the other to drive the feed motion and table. A comparison was made between a slab milling machine with a fluted spiral cutter for heavy work and a machine which was really a cold sawing machine but fitted with a milling or facing head with inserted tools or cutters. It was found that the latter class of milling only absorbs about half the power for a given weight of material removed in a given time. The author describes the application of motors to particular tools. A ¼ h.p. motor mounted on a square steel bar with an emery wheel on the armature shaft is a very useful tool for trueing up the centres of lathes.

Discussion.—**Turnbull** thought the tendency in the future would be to use portable electrically driven tools to save the cost of moving heavy castings and the cost of large tools. **Broadbent** pointed out that in the case of large machine tools it may take two men a considerable time to shift the belt to change the speed, but with a motor driving a single machine the speed can be varied by moving the regulating switch. R. B. R.

1404. *Fire-Alarm Installation at Pforzheim.* (Elektrotechn. Zeitschr. 22. pp. 158–160, Feb. 14, 1901.)—This installation is worked on the system of Mix and Genest, in which the substations are normally connected in series in a closed circuit including, at the central watch station, two Morse recorders, a battery, and an indicating galvanometer, so that, on any fault occurring, indication thereof will be given by the galvanometer and by an electric bell in a local circuit controlled by a relay. The line is also connected to earth at the central station between the Morse recorders through a strong battery, so that, on connecting the line to earth at any of the substations by means of a key, the circuit of the battery at the central station will be closed, an indicator-drop falls, and local circuits, including alarm-bells, are closed by the armatures of the recorders. On momentarily short-circuiting the electromagnet coils of the Morse recorders, a strong current will pass through an electromagnet at the calling-up station, and this electromagnet will release clockwork mechanism driving a commutator or interrupter which will cause a predetermined set of signals to be sent five times into the line to actuate the Morse recorders at the central station, and at the same time a bell is rung at the substation indicating that the call has been received at the central station. The clockwork, on running down, breaks the earth connection. The keys used to actuate the apparatus at the substations can only be removed by the official who comes to rewind the clockwork. The original paper is illustrated by diagrams of connections and photographs. C. K. F.

1405. *Pelton-wheel Installations.* **G. J. Henry, Jun.** (Journal of Electricity, S. F. 11. pp. 30–35, Jan., 1901.)—This paper gives a description with illustrations of some of the principal installations in the United States of Pelton water-wheels of large size up to 1,650 h.p., and working under heads up to 1,430 feet. G. H. B.

1406. *Cable Estimating.* **R. Appleyard.** (Elect. Rev. 48. pp. 354–355, March 1, 1901.)—It is of use to know the change in weight of the conductor or the change in weight of the dielectric corresponding to a change of one mil. in the diameter of either. If w be the weight in lbs. of unit length of a cylinder of diameter d, $mw = d^2$, where m is a constant. If the change in diameter is 1 mil., the corresponding change in weight at any diameter, d, is given by—

$$w_1 - w_2 = 2d/m.$$

where d is measured in mils. We can tabulate the value of $2/m$ as below for various materials; to make use of this table, multiply the diameter in mils. by the constant, which gives in lbs. per mile of cable the error in weight which would arise from an error of 1 mil. in the diameter.

	Density.	$2/m$ St. Mile.	$2/m$ Nautical Miles.
Gutta-percha	1	0·00360	0·00415
Copper	8·9	0·03206	0·03696
Indiarubber	1·3	0·00468	0·00540
Iron	7·8	0·02809	0·03239
Brass	8·4	0·03026	0·03488

A similar expression might be found for the change in resistance corresponding to one mil. change of diameter, for the resistance is measured by the reciprocal of the weight. M. O'G.

REFERENCES.

1407. *Steam Heating from Central Stations.* **A. D. Adams.** (Elect. World and Engineer, 37. pp. 269–271, Feb. 16, 1901.)—A discussion of the distribution of live and exhaust steam from central electric stations for heating purposes. A. H. A.

1408. *Electricity in Iron and Steel Works.* **S. F. Walker.** (Eng. Mag. 20. pp. 858–876, Feb., 1901.)—Various appliances are here illustrated and described, including furnace-charging apparatus, electromagnetic cranes, magnetic separators, appliances for handling beams, &c.

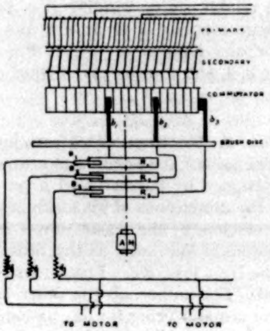
GENERATORS, MOTORS, AND TRANSFORMERS.

1409. *Windings for Continuous Current Armatures.* **A. Rothert.** (Ecl. Électr. 26. pp. 467–473, March 30, 1901.)—The author deals with toothed armatures wound with wire on formers. With a series or multiple series winding the number of slots may be reduced to one half or one third the number of plates in the commutator, without causing sparking. The turns included between a pair of brushes are spread over the whole surface of the armature, so that a want of symmetry in the magnet field does not matter. With slots 12 to 20 mm. wide and an air space of 3 to 7 mm., either the pole-pieces or the whole magnet must be laminated. The paper includes diagrams showing the arrangement of 2, 3, and 6 coils per slot. With 4 or 8 pole dynamos, with 3 commutator plates per slot, 3 coils can be wound with a single length of wire on one former, leaving two loops, which are afterwards cut, dividing it up into 3 coils. This cannot be done with 6 poles and 3 plates per slot, or 4 or 8 poles and 2 plates per slot. This is for simple series winding; with a double series winding it is just the opposite. In a series winding with a large number of turns, it is not necessary that all the sections should have the same number of turns. For instance a former with three sections may have 3, 4, and 3 turns per section, and the next one 4, 3, and 4 turns per section. R. B. R.

1410. *Large Generators.* **A. Rothert.** (Elektrotechn. Zeitschr. 22. pp. 191–194, Feb. 28, 1901.)—The author draws an interesting comparison between some large generators designed by Parshall and a set of machines designed by himself. In finding the dimensions of his machines, Parshall commences by assuming a certain efficiency; the waste power is then suitably apportioned to the various sources of loss, such as the heat loss in the field coils, that in the armature, the iron loss, &c. From these the necessary cooling surfaces are determined. The author, on the other hand, uses a coefficient which gives the length of armature core for any assumed diameter. He next chooses the number of poles, which is regarded as dependent mainly on the angular velocity, and fixes the dimensions of the armature so that the polar surface becomes approximately a square, the steel field-core being cylindrical. The machines under consideration range from 125 to 650 kilowatts as regards output, and from 150 to 80 revs. per minute as regards speed.

Parshall gives 2·25 per cent. as the average value of the loss due to armature resistance. In the author's machines this quantity is 2·7 per cent. for the larger sizes, and reaches a value of over 4 per cent. in the 125 k.w. size (125 revs. per min.). The current-density in the armature conductors amounts to 2·3 amperes per sq. mm. in Parshall's, and to between 2·68 and 2·95 amperes per sq. mm. in the author's machines. The apparent maximum induction in the teeth is in Parshall's machines, 21,500, and in the author's, 23,500. In the latter machines there are 2 or 3 commutator segments per tooth, and the slots are from 10 to 17·5 mm. wide (in the case of large machines 13 to 14 mm. is an average value), and from 35 to 45 mm. deep. The induction in the armature core is from 11,500 to 12,000 in the author's machines. The peripheral velocity is about 12 metres per sec. in Parshall's machines, and varies from 8 to 10·5 in the author's. Parshall uses 10 poles where the author uses 14. The leakage coefficient is given by Parshall as 1·15 on open circuit and 1·18 at full load; the author's figures being 1·14 and 1·23. The polar arc in Parshall's machines is 80 per cent., and in the author's 72 per cent., of the pole-pitch. The field-core induction in Parshall's machines is 15,800, in the author's somewhat higher. The paper concludes with a detailed account of a generator exhibited by Siemens and Halske at the Paris Exposition. [See also Abstract No. 243 (1901).] A. H.

1411. *Starting Device for Three-phase Railway Motors.* **A. Krebs.** (Elekt. Runds. 18. pp. 85–86, Feb. 1, 1901.)—This device, proposed by the author and illustrated in the accompanying sketch, is intended to reduce the heavy starting currents taken by 3-phase motors, and to provide a means of controlling the speed of, and braking, such motors. The leading idea is to vary the frequency of the currents supplied to the motor. The device is specially intended for high-speed railway service. High-tension three-phase currents are, by means of three trolleys, tapped from overhead conductors and led into the primary winding of a transformer placed on the locomotive. This transformer has a ring core, and its secondary is arranged like an ordinary Gramme winding with a commutator, against which press three brushes, b_1, b_2, and b_3, spaced 120° apart. The commutator is fixed, but its brushes are capable of rotation, being fixed to a brush disc driven by a small auxiliary motor AM. The brushes are connected to three slip-rings, R_1, R_2, and R_3. From these latter connections are carried, through the brushes B_1, B_2, B_3, to the main motors, with, if necessary, the interposition of small starting resistances. If the brushes are rotated synchronously, then it is evident that the currents supplied to the motors are of zero frequency. As the speed of rotation of the brushes is gradually decreased, the frequency of the motor currents increases, until when the brushes are brought to rest the frequency equals that of the primary currents. By this means very rapid acceleration with currents not exceeding the normal ones may be obtained. Further, a braking effect is easily produced by setting the brushes in rotation, and thereby causing the motors to act as generators. A. H.



1412. *Friction and Hysteresis Losses in Induction Motors.* **J. Hissink.** (Elektrotechn. Zeitschr. 22. pp. 226-227; Discussion, pp. 227–228, March 7, 1901. Paper read before the Elektrotechn. Verein, Dec. 18, 1900.)—It has frequently been observed that whereas in the case of transformers the calculated hysteresis loss corresponds closely to that determined experimentally, the experimental determination in the case of induction motors constructed of the same kind of iron gives results which are from 2 to 2½ times those obtained by calculation. The method commonly employed for separating the losses consists in measuring the total power taken by the motor when running light at different p.d.s. It is then assumed that, since the speed of the motor at the various p.d.s is practically the same, the friction loss remains constant. By producing the curve connecting power with p.d. backwards, this supposed constant frictional loss may be obtained. The author points out that this reasoning is only applicable to an ideal motor whose rotor is absolutely concentric with the bore of the stator. The air-gap being extremely small, the slightest amount of eccentricity will result in (1) a strong magnetic pull which will increase the friction loss; and (2) an irregular distribution of the magnetic flux, which will increase the hysteresis loss. These two effects are sufficient to account for the great increase in the observed loss as compared with the calculated one. The author describes experiments which confirm this view. In one case, the air-gap of a motor with a squirrel-cage rotor was gradually increased, and—as might have been expected—it was found that the hysteresis loss decreased rapidly at first, then more and more slowly. In order to separate the stator hysteresis loss from the friction loss, the author measured the power taken by the stator when the rotor was (*a*) running light; and (*b*) driven synchronously by an auxiliary synchronous motor coupled to it.

Discussion.—**Görges** stated that the increase in the hysteresis loss had frequently been observed in the works of Siemens and Halske. He drew attention to the fact that with a different number of slots in the stator and rotor cores the induction in the teeth underwent extremely rapid fluctuations, and this would partly account for the increase in the hysteresis loss. A. H.

1413. *New Form of Synchronous Motor.* **H. Grob.** (Elektrotechn. Zeitschr. 22. pp. 211–212, March 7, 1901.)—The author proposes to couple the stator and rotor circuits of an ordinary induction motor in series with each other, and then across the supply mains. The polyphase currents in the stator and rotor windings will give rise to two rotating fields. Let the connections be so arranged that the fields rotate in opposite directions. Further, let the rotor be run up to a speed double that of its field, but having the opposite direction. The result is to impart to both fields the same velocity *in space*, and hence to enable the stator field to exert a torque on the rotor should the latter be displaced from the position of equilibrium. The author finds that the behaviour of such a motor may be graphically represented by a diagram which closely resembles Heyland's diagram for an induction motor. Such a motor is obviously not self-starting, and must be run up to the speed of synchronism. The author compares the behaviour of an induction motor as ordinarily used with that of the same motor when its circuits are joined in series with each other as explained, the same values of the iron and copper losses being assumed in each case. This will require a p.d. of supply for the synchronous motor equal to double that of the non-synchronous one. The speed and power of the synchronous motor will (as already explained) be double those of the other; its no-load current will be half, its maximum torque double, its power-factor higher than, and its efficiency about equal to, those of the non-synchronous motor. Assuming next that the motors run at the same speed (in order to obtain this, it will be necessary to re-wind the synchronous motor so as to give it double the number of poles), the author finds that the supply p.d. and no-load current will be the same, that the maximum torque of the synchronous motor will be double, and its power-factor higher than those of the non-synchronous motor.[1] A. H.

1414. *Transformer Design.* **W. B. Woodhouse.** (Electrician, 46. pp. 625–627, Feb. 15; and 687-689, March 1, 1901.) A practical discussion is given of the design of transformers. The relative merits of the core and shell types are stated, and formulæ are given for the dimensions of the stampings. The importance of considering the rise of temperature in large transformers is pointed out. If we have two similar transformers, and the linear dimensions of the one are n times those of the other, and if we keep the flux density the same in each, and if the same proportion of the space be taken up by the windings, then while the output increases as n^3 the cooling surface only increases as n^2. The following rules are given. For an air-cooled transformer with natural draught the rise of temperature in degrees Fahrenheit is $300\,m^{\frac{3}{4}}$ where m is the ratio of the watts wasted to the area of the cooling surface in square inches. For an air-cooled transformer the rise of temperature is $225\,m^{\frac{3}{4}}$. Kapp's empirical formulæ to predetermine the pressure drop in the secondary are given. The author states that much labour will be saved in designing if certain curves, which he describes, showing temperature rise, watts wasted in hysteresis, and connecting linear dimensions with cooling surface, be plotted out. He concludes by working out completely the design of a ten kilowatt core transformer. A. R.

REFERENCES.

1415. *Comparison of Surface-Wound and Slot-Wound Armatures.* **P. M. Heldt.** (Amer. Electn. 13. pp. 106–107, March, 1901.)—The author gives details of two dynamos of about the same weight, one with a smooth core armature giving $7\frac{1}{2}$ kw. at 1,200 revs., the other with slotted armature giving $12\frac{1}{2}$ kw. at 940 revs. The bore of the machine with smooth core was $10\frac{13}{16}$ inches, and of the other $12\frac{3}{8}$ inches. R. B. R.

1416. *Asynchronous Generators.* **O. M. Corbino.** (N. Cimento, 1. pp. 178–182, March, 1901.)—The author treats analytically and geometrically the theory of an asynchronous rotary field motor, when acting as a generator. G. H. B.

1417. *Pressure Drop in Three-Phase Generators.* **F. Niethammer.** (Elektrotechn. Zeitschr. 22. pp. 255–256, March 21, 1901.)—The author develops a graphical method of predetermining the regulation of a three-phase generator. The method is based on a consideration of the effective ampere-turns acting on the armature, these ampere-turns being obtained by suitably compounding the field and armature ampere-turns, due account being taken of magnetic leakage. The details of the method do not admit of a useful abstract. A. H.

1418. *Compounding of Alternators.* **Strymeersch.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 19–46, March 21, 1901.)—This is simply a description of the known methods due to Hutin and Leblanc, Boucherot, and Blondel. W. G. R.

1419. *Distribution of Magnetic Flux in Induction Motors.* **J. B. Krantz.** (Elektrotechn. Zeitschr. 22. pp. 274–275, March 28, 1901.)—A mathematical paper dealing with this problem. A. H.

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[1] In a foot-note, the author states that since his paper was written the arrangement described has been patented by another inventor.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1420. *Economical Current Density for Small Conductors.* **J. Whitcher.** (Elect. Rev. 48. pp. 361–362, March 1, and 396–397, March 8, 1901.) The writer points out the absurdity of insisting on a 2 or 3 per cent. limit for the voltage loss in long runs, and by applying the Kelvin law finds that the economical current density should be 700 or 800 amperes per square inch, on the average, for general wiring work. The cost per unit is taken at 4d., and interest and depreciation at 7½ per cent. W. H. E.

1421. *Transformer Regulation on Three-wire and Three-phase Systems.* **M. v. Dolivo-Dobrowolsky.** (Elektrotechn. Zeitschr. 22. pp. 265–266, March 21, 1901. Paper read before the Elektrotechn. Verein, Feb. 26, 1901.)—When a transformer with two legs is connected to a three-wire circuit, one leg-winding being on each side, a difference in the load on the two sides produces very large variations in the pressure; this is due to the primary current required on the loaded side being unable to pass through the less loaded side, when the two primary coils are, as is usual, connected in series. When the two windings are on one leg only, or both on each leg, the regulation is better, but not perfect. The method adopted by the author to obviate this difficulty, is to connect the two primary windings, corresponding to the two secondaries in parallel. The regulation, then, is equally good as with two-wire circuits, even with great variations of load on the two sides. The same object is attained in three-phase circuits, by connecting the primary in mesh and the secondary in star. Such transformers with mixed connections can be connected to work in parallel, but two transformers, one with mixed and the other with similar connections, will not work in parallel. G. H. B.

1422. *Economy of Copper in Transmission Lines.* **M. Latour.** (Écl. Électr. 26. pp. 279–281, Feb. 23, 1901.)—The author points out, from considerations partly mathematical, that the use of accumulators at the distant end of a line may conduce to economy in the cost of a transmission line, in cases where the power is transmitted over comparatively short distances. This is due to the possibility of sending along the transmission line a constant current, which is equivalent to the mean amount of current required throughout the day, or, in other words, to the possibility of maintaining a constant load on the running machinery. He shows that if, under the usual conditions, full load is maintained on the line during eight hours of the day, and there is no load during the remaining sixteen hours, the loss in the transmission line is three times as great as it would be, if with the use of accumulators it were possible to maintain a steady load on the line, equal to the mean load required. It is pointed out that this requires to be somewhat corrected to allow for the fact that the efficiency of the batteries is not 100 per cent.; but even allowing for this, the line loss would be much smaller in the one case than in the other. The matter may be put in another way: it is possible to have much less copper in the line in the one case than in the other, and yet have equal daily loss in the line; and, consequently from the point of view of the author, the use of accumulators may be said to conduce to economy in the cost of copper. No estimate is, however, made of the cost of plant under the two conditions, though it is pointed out that the use of accumulators dispenses with the cost of transformers at the distributing station. W. H. S.

1423. *Plant for Electrical Distribution.* **C. F. Scott.** (Frank. Inst., Journ. 151. pp. 282–308, April, 1901.)—This paper begins with a comparison between the advantages of alternating and direct current for central station work, the author advocating the use of the former for long-distance transmission. A general description follows of the construction of a Westinghouse flywheel alternator, the advantage of a large number of slots in the armature being dwelt on, as tending to reduce the self-induction of the machine. The problem of parallel running is considered, and the analogy between two electrically-coupled generators and two gear wheels transmitting power to a shaft is developed at length. Engines with a considerable speed variation between no load and full are better for parallel working than those which regulate very closely; too great sensitiveness in the governor sets up a tendency to hunt, which can be counteracted by the use of a dash pot. The construction and uses of rotary converters are described; an effective remedy for the oscillations sometimes set up in the armature of a rotary by variation of speed of the generator is a copper shield round the field poles. Rotaries and synchronous motors, if running badly, may influence adversely the behaviour of similar machines on the same circuit; induction motors, on the other hand, facilitate the operation of rotaries and also the parallel running of the generators. A description follows of the Westinghouse type "C" induction motor, and such motors generally are compared with direct-current motors from the points of view of efficiency, simplicity of construction and working, capacity for overload, reliability, &c.—the balance of advantage being, in the author's opinion, in favour of the former.

In conclusion, the author expresses the opinion that the alternator is the form of generator which will be used in the central station of the future, and that the inherent possibilities of the gas engine, and its greater efficiency as compared with steam, will be developed to an extent which will effect an industrial revolution. The article is illustrated by photo blocks. B. P. S.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1424. *Trafford Park Power Station.* (Elect. Engin. 27, pp. 366–371, March 15, and 402–405, March 22, 1901.)—Trafford Park, near Manchester, is bounded on two sides by the Manchester Ship Canal and on the other two by the Bridgewater Canal. Numerous factories are established on the estate, and the Trafford Park Power Station has been laid down to supply current for power and lighting purposes, and also Mond gas for heating, to consumers on the estate. Negotiations are in hand for supplying three local authorities whose districts adjoin Trafford Park.

The *system* is continuous current three-wire at 500 volts between the outers; for distant consumers a three-phase high-tension supply is contemplated.

Gas plant has been put down on the Mond system for supplying gaseous fuel to the boilers, with recovery of by-products. The fuel used is slack at 7s. per ton; including the labour of handling and removing the ashes, the cost is 8s. 6d. One ton of sulphate of ammonia, worth £11, can be obtained from 23 tons of coal; the by-product, therefore, per ton of coal, is worth 8s. more than the original cost of the coal. The steam for the producers will be obtained from the steam engine exhausts. The gas, as it leaves the producers, is passed through large regenerator pipes to the washers, from which, after extraction of the ammonium sulphate, it passes to the mains supplying the boilers and the consumers. The boiler furnaces are arranged to burn either coal or gas ; the gas is burnt below the level of the fire-bars, in a chamber divided by a zig-zag partition of firebrick. Air is admitted at one side of the partition and gas at the other, combustion taking place above the partition. The products of combustion pass through interstices in a crown arch of fire-brick ; this arch, becoming very hot, ensures complete combustion. A small furnace is used for heating the Schmidt superheaters, which will give 300° F. of superheat. The makers guarantee a saving of 7 lbs. of steam per i.h.p. by the use of the superheater.

The *boiler-house* contains four Babcock and Wilcox boilers, and one tubular boiler of a new type by Tinkers.

The *engine-room* contains four Raworth engines coupled direct to Mather and Platt multi-polar direct-current dynamos ; two 500 h.p. engines are mounted on one shaft and drive one dynamo, giving 1,200 amperes at 500–550 volts, running at 200 r.p.m. The exhaust steam, when not required for the producer blast, is condensed in injector condensers of the Ledward type. Centrifugal pumps driven by Royce motors draw the cooling water from the Bridgewater canal. Two balancing sets by the Electric Construction Corporation are capable of dealing with 50 amperes each.

The *feeders* are three in number, supplied and laid by Glover and Co. ; they consist each of three separate cables insulated with paper and lead covered. The outers have a section of 0·5 sq. in., and the middle wire a section of 0·125 sq. in. They are laid in Doulton conduits.

The *system of charging* is on the maximum demand system, being 1½d. per unit up to an average use of the maximum demand for 1,200 hours per annum, and ½d. per unit for further energy. On this basis an ordinary factory would obtain energy for less than 1d. per unit. For lighting the charge is 4d. per unit for the first 400 hours per annum, and 1½d. per unit for energy above this quantity. A load-curve for Feb. 22, 1901, shows a variation in current of from 165 to 370 amperes. For extensions the engineers are contemplating the use of large gas engines coupled directly to dynamos.

The paper is illustrated by a map, eleven scale drawings, and several photographic views. G. H. B.

1425. *Nottingham Corporation Electricity Works.* (Elect. Rev. 48. pp. 63–69, Jan. 11, 1901.)—The present plant has a capacity of 5,600 kw., and an entirely new station is about to be erected with a capacity of 10,000 kw. Owing to a high load factor (600 h.p. in motors), the price is very low—5d. and 2d. on the Wright system. In the new station there will be 9 Willans-Siemens sets, most of which are now running. The engines are of the standard "3S" type, compound non-condensing, running at 300 r.p.m. The dynamos have eight poles, with circular cast steel magnets, the cores being cast with the frame and the polar extensions bolted to them. The edges of the pole-tips are double wedge-shaped, so that the polar arc is greater at the middle of the armature than at the ends. The toothed armature weighs 9 tons, and no flywheel is required. The shunt field rheostat is mounted at the side of the machine, and consists of two switches, so as to secure fine adjustment with few steps. The main terminals are below the floor level, and are approached by a stairway. The cables are Callenders in bitumen casing or armoured, and laid direct in the ground. The connections amount to 127,000 8-c.p. lamps and 600 h.p. in motors.

The traction sets resemble the lighting sets and have no flywheels, but the engines have automatic variable cut-off governors as well as throttle governors, and the dynamos are compound wound. The new boiler-house will contain 14 dryback boilers by Edwin Danks, 16 feet long by 8 ft. 6 in. diameter, with two furnaces 3 feet in diameter, and 86 3-inch return tubes. There are two Berryman exhaust steam feed-water heaters, each 21 ft. 6 in. high by 4 ft. 3 in. diameter. Condensed water from these and from the drains is collected in two tanks, which are also connected with the town mains. Four Weir feed-pumps draw from these tanks. Feed piping is in duplicate throughout. Each boiler is fitted with an anti-priming steam chamber, from the top of which is taken the connection to the steam main. Steam pipe joints are made with Taylor's corrugated brass rings. There are 12 cars now in use. The overhead trolley wire is flexibly supported in "bowstring" manner. E. H. C.-H.

1426. *Nottingham City Tramways.* (Tram. Rly. World, 10. pp. 51–59, Feb. 1901.)—Since 1877, when the tramways were opened, Nottingham has more than doubled; but no addition has been made to the original ten miles of line, in spite of the heavy traffic. During 1899 the population was carried 34 times, the earnings being 14·01d. per car-mile. The district is hilly, but the steepest gradient is 1 in 14. The rails are 7-inch girder type, 107 lbs. per yard, in 60 feet lengths. With proper appliances no difficulty has been found with the 60 feet lengths. Joints are made with fish-plates 2 ft. 7in. long, with eight 1-inch bolts, the pair of plates weighing 77½ lbs. Secured to the bottom flange of the rail by four ⅞-inch bolts is a sole plate 2 ft. 6 in. long by 8 inches wide and ¾ inches thick. Duplicate crown bonds are used between the fish-plates and the rails, and Chicago cross bonds every 40 yards. Points and crossings are curved, not straight. Six inches of 6:1 Portland cement concrete are laid under the track throughout. There are 57 double-deck cars of the new Liverpool pattern, holding 22 inside and 34 outside, mounted on "21 E" Brill trucks with 6 feet wheel base and Miller's wheels. Each motor gives 30 h.p. at 8 m.p.h. Spencer's patent slipper brake is used in addition to hand and electric brakes, the latter acting by short-circuiting each armature on itself. Feeder cables are Callender's vulcanised bitumen laid in vitrified stoneware ducts. Feeders are so arranged that if the line feeder breaks down, the switches can be reversed so that the return feeder takes its place. The trolley wire has a diameter 0·409 inch. A new power station, fairly central, is under construction. Its boiler-house, 240 feet by 53 feet, will contain 16 Lancashire boilers, 30 feet by 8 feet, for 160 lbs. per sq. in., fired by Vicar's mechanical stokers. Pits are provided for 300 tons of coal, which will be dealt with by conveyors and elevators. The engine house will be 206 feet by 40 feet, and will hold twelve 700 h.p. Willans-Siemens sets. The chimney stack will be 220 feet high, by 15 feet inside diameter at base. E. H. C.-H.

1427. *Lowestoft Electricity Works.* (Elect. Engin. 27. pp. 294–296, and Supplement pp. 1–8, March 1, 1901.)—The four boilers are by Babcock-Wilcox, and the bottom row of tubes is so arranged as to form a double-combustion chamber, for burning bituminous coal. The working pressure is 200 lbs. per square inch. The engines are of the Musgrave enclosed type, with piston valves, the high-pressure valve being controlled by an automatic governor. The capacity of the plant will be 475 kw. at 2 × 230 volts; there is also a battery of Chloride cells giving 100 amperes for four hours, or 270 for one hour. There are four feeders, two being triple concentric, armoured and laid direct in the ground. All the mains were supplied by Callender, and have vulcanised bitumen insulation. The distributors are laid in wooden troughs filled with refined bitumen.

With a view to future extensions, three spare 3-inch stoneware pipes were laid in the same trench as the present feeders.

For street lighting there are 68 five-ampere enclosed Crompton arc lamps, run four in series on 7/18 cable across the outer distributors, and incandescent lamps on the arc posts. An automatic cut-out is provided in each lamp so as to substitute a resistance in case of failure in the arc. W. H. E.

1428. *Isle of Thanet Tramways.* (Electrician, 46. pp. 968–975, April 19, 1901.)—These tramways have been constructed to connect Margate and Ramsgate, and include at present about eleven miles of track. Electric lighting will also be undertaken by the Tramway Company, and Provisional Orders have been obtained for several places on the line of route. The power-house is situated about the middle of the line, nearly midway between Margate and Ramsgate. It contains four Babcock boilers, each with a heating surface of 3,140 square feet, which supply steam to a single main 10 inches in diameter. Two vertical feed pumps are used, each having a capacity of 5,000 gallons an hour. Water for feed and condensing purposes is obtained from a well 150 feet deep, the feed water being softened by the Desrumaux apparatus, and subsequently heated by an economiser of 240 tubes. The engine-room at present contains two 200-kw. continuous-current traction generators, and two 300-kw. three-phase generators, giving their output at 2,500 volts. The continuous-current sets are driven by Allis engines at 135 r.p.m., the engines having flywheels 14 feet in diameter, weighing over 10 tons. The three-phase sets are direct coupled to Belliss engines, running at 300 r.p.m. There are three Wheeler condensers, each having a cooling surface of 1,570 square feet, and these are worked in conjunction with a Barnard-Wheeler cooling tower. The travelling crane in the engine-room has a capacity of 15 tons, and covers a span of 49 feet. The car-sheds contain eight tracks with continuous inspection chambers under all the tracks, and can hold about 40 cars. The cars are partly on single trucks and partly on bogies, and all are double decked; they seat 50 and 62 passengers respectively. The steepest gradient on the line is 1 in 13, and the sharpest curve has a radius of 38 feet; the gauge is 3 ft. 6 in. The line is mainly composed of double track, which is to a large extent interlacing. The rails weigh 83 lbs. per yard. On straight runs the poles are about 120 feet apart. The substations at Ramsgate and Margate are to contain two and four 100-kw. rotary converters respectively. The article contains drawings showing the general plan and cross-section of the power-house, the construction of single and interlacing track, the connections on the substation switchboard, &c. W. H. S.

1429. *Huddersfield Electric Tramways.* (Elect. Engin. 27. pp. 222–233, Feb. 15, 1901.)—The Corporation own 52 miles of single track, varying in altitude between 200 and 800 feet above sea-level. The equivalent of nearly 16 miles of single track has now been equipped electrically. The power-station is central, on the River Colne, and all current is supplied direct at 500 volts. The boiler-house is 107 feet long, 59 feet wide, and 23 feet high, constructed for eight Lancashire boilers. Outside the building a coal hopper and elevator are arranged in conjunction with Vicars' mechanical stokers. The engine-house is 130 feet long, 42½ feet wide, and 35 feet high. Car-sheds provide for 25 cars with inspection pits between each line of rails. Recent extensions of the steam tramways were made with 98-lb. girder rails having a groove only ⅞ inch deep; it was found that the tread wore away so quickly that the wheels ran on their flanges in less than 15 years. The new rails are of the same weight, but with grove $1\frac{1}{16}$ inch deep, and have fish plates 2 ft. 6 in. long. Each joint is double bonded with 0000 "Columbia" bonds, hydraulically pressed into drilled holes: cross bonds are placed every 120 feet.

The power-house now contains three Lancashire boilers, 30 ft. × 8 ft. 6 in. diameter, constructed for 180 lbs. working pressure. Their outside shell is of $\frac{15}{16}$ inch plate, the flues 3 ft. 5 in. diameter in 18 rings with welded longitudinal seams and flanged ends. The Vicars stokers have special clinkering nozzles to allow the clinker to be broken while the furnaces are working. Coal from carts is tipped into an elevator pit, whence steel buckets on an endless chain transfer it to a conveyor, along which it is moved by a large screw to the furnace hopper, whence the supply to the furnaces is automatically regulated. For driving this elevator and conveyor, and also the economiser scrapers, a 10-b.h.p. motor is provided, driven from the bus-bars or from the station lighting set.

The boiler mountings and all valves are Hopkinson's, and include a new form of accessible check-feed valve arranged so that an upper part of the valve can be closed, allowing the check valve and seat to be removed while the boiler is in use. The steam and water piping is in duplicate, the former being of mild steel, the main branches lapwelded with screwed flanges, into which the pipes are expanded. A Musgrave superheater with 38 tubes is placed at the back of each boiler to ensure dry steam: a by-pass pipe can be put round the superheater if required. The main engines are Musgrave's vertical inverted cylinder compound condensing type, with automatic cut-off gear. The cylinders are 17½ inches and 35 inches with 35-inch stroke. The air-pump is 24 inches diameter, 14-inch stroke, the pump bucket having a series of small indiarubber valves, also delivery grid with rubber valves. The arrangement works well and greatly reduces shock on closing. The jet condenser is supplied from the River Colne. The cast-iron engine flywheel is 18 feet diameter, and has 10 tons in rim alone. Forced lubrication is supplied to all parts by two ram pumps, each capable of doing the whole lubrication if necessary. Each of the two engines is rated at 520 i.h.p. at 90 r.p.m., with 160 lbs. steam, and will work up to 650 i.h.p. The generators are of the compound-wound multipolar type with inwardly projecting poles and slotted armature keyed on to the engine shaft: each gives 375 k.w. at 500 to 550 volts. A 25-k.w. Reavell-B.T.H. set is provided for station lighting, &c. The engine-house is spanned by a 25-ton crane. The switchboard is of B.T.H. standard panel design, as also is the equipment of the overhead line and of the cars. The trolley wire is 00 B. & S. hard-drawn copper on span wires, side or double brackets, with poles 120 feet apart. Both line and rail are fed at three separate points, where switches are arranged so that the rail-feeder can be used for line feeding if the line feeder breaks down. The return conductors are not earthed at the station, but at central points on the routes, where recording ammeters are placed. The extreme drop is 3½ volts in the town and 5 volts in the outskirts. The cars, by Milnes, have bodies 18 ft. 6 in. long, and carry 24 inside and 33 outside. They are mounted on Brill maximum traction trucks, and each carries two G.E.-58 motors rated at 27 b.h.p. each. The controllers are of the B.-18 type with electric brakes, using the motors as generators on resistances. The average period of service of the whole of the drivers, conductors, &c., on the tramways is 10¾ years, and the yearly outlay in compensation for accidents during the last five years with steam traction averaged £165, equal to 7d. per car per day, whereas insurance companies ask premiums equivalent to 10½d. per car per day. E. H. C.-H.

1430. *Darwen Refuse Destructor and Electricity Works.* (Tram. Rly. World, 10. pp. 60–71, Feb., 1901.)—This town adjoins Blackburn, and part of the tramway lines are used by the cars of both Corporations. In Darwen the greater part of the steam required for traction and lighting is generated by two Meldrum destructors. Each consists of furnace, combustion and dust-deposit chamber, and regenerator, with a Lancashire boiler measuring 30 feet by 8 feet. The furnace extends alongside the boiler for a distance of 19 feet, with a width of 5 ft. 6 in., and has four doors, each with its own ashpit. Each ashpit is fitted with Meldrum forced draught apparatus, consisting of steam blowers which draw air through the regenerator. The flames and gases pass into a combustion chamber 17 ft. 6 in. long, 4 feet wide, and 10 ft. 6 in. high, placed at right angles to the furnace and extending across the end of the boiler. The hot gases pass through, along, and then under the boiler, as usual, and afterwards traverse the regenerator in a set of 3-inch iron pipes, thus heating up the air around them, which is used for the furnace draught. The chimney is 240 feet in height, but a temporary iron chimney, 80 feet high and 3 feet in diameter, was used for seven months, and no complaints were received from residents in the vicinity, the escaping smoke being scarcely visible. A 48 hours' test gave the following results :—

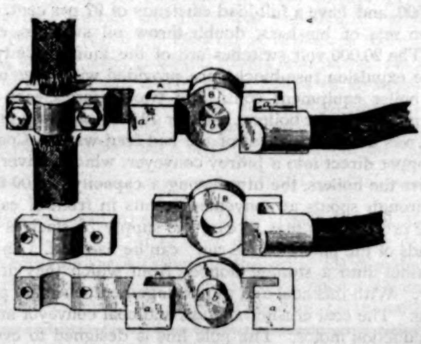
Total quantity of refuse (consisting almost entirely of unscreened ashpit refuse)	63·88 tons.
Average moisture	38 per cent.
Weight of clinker remaining (19½ tons)	30·6 per cent.
Water evaporated (from and at 212°) per lb. of refuse	1·55 lbs.
Average steam pressure per square inch	183 lbs.
Average temperature of combustion chamber	1,633° F.
,, ,, ,, gases after leaving boiler	703° F.
,, ,, ,, gases after leaving regenerator	585° F.
,, ,, ,, feed air from regenerator	328° F.

The quantity of refuse dealt with daily is from 32 to 38 tons, though the plant can consume 70 tons daily. The population numbers 40,000, and the destructors generate steam for about 900,000 kw.-hours per annum. Two coal-fired boilers are required in addition. The average evaporation has been 1·5 lbs. of water (at 212° F.) per lb. of refuse, giving a value for the refuse of about 3s. per ton, while the cost of destruction is about 2s. per ton. The power is sold to the Electricity Department by the Sanitary Committee at the rate of 0·6d. per net electrical unit. The electrical plant is described in the paper and is on ordinary lines. W. H. E.

1431. *Recent Tramway Work in San Francisco.* **S. L. Foster.** (Street Rly. Journ. 17. pp. 187–193, March, 1901.)—Several old cable lines of the Market Street Railway Company have recently been converted to electric traction. The old cable tube was left, the slot rails removed, and the tube and sheave pits filled up. Instead of fish-plates and bonds, Falk cast-welded joints were used. Careful tests on 2,000 joints showed that in 80 per cent. of the sound cast-welded joints the conductivity was not less than that of an equal length of jointless rail. On the latest work, after eleven months' use, only 0·24 per cent. of the cast-joints were broken. The rails are cross-bonded every 150 feet as a safeguard against broken welds. It is found best to omit every fourth joint, leaving the welding of the omitted joints till some cold night. In this way the cast iron is practically always under compression, and is therefore less liable to crack with a sharp blow than if under tension. One gradient of 17½ per cent. is 200 feet long, but the electric cars are operated up and down without mechanical assistance. On two 25 per cent. gradients the ascending and descending cars are coupled by cable while on the grade. A new standard car has been adopted, 40 feet long, equipped with four G.E. 25-h.p. motors. This takes twice the kw.-hours per car-mile that the 28-feet single-truck cars do, but the extra cost of power is more than offset by saving on wages per passenger carried. Single trolley poles are used, even on the 40-feet cars. Special track brakes are used, consisting of wooden replaceable shoes forced down on to the rails between the wheels of each truck. The brake handle is an upright lever, and acts on the shoes through toggle joints. It is claimed that this form of lever is responsible for the compensation claim being only 1 per cent. of the gross earning in San Francisco as compared with from 3 to 7½ per cent. in the Eastern States. With the rotary brake handle valuable time is always wasted in taking up slack. Four sand-boxes are used, one over each rail at each end of the car. A special car for engineers' use is equipped with two G.E.-1,000 motors, and will easily haul 8 tons of dead load over the heavy grades. E. H. C.-H.

1432. *Albany and Hudson Third-Rail Road.* (Street Rly. Journ. 17. pp. 101–112, Feb., 1901.)—This is the longest third-rail electric line in the world, being 37 miles in length. It is supplied with power from the Stuyvesant Falls, which are at a point on the line about 10 miles from one end. There is also an auxiliary steam plant of 1,750 h.p. The electric generators include three 750-kw. three-phase generators, working at 25 cycles and 12,000 volts; also two 200-kw. 600-volt direct-current generators for supplying the section of the line nearest the power-house. The 12,000-volt current is taken by overhead wires to three substations, and is there reduced by transformers to 380 volts, and then supplied to rotaries which convert it into direct current at 600 volts. The power-house also contains some single-phase generators, which are used for lighting purposes; these work at 60 cycles per second. The frequency of the three-phase machines is too low for lighting purposes, but was considered the most suitable for use in connection with rotary converters. Hence two different frequencies were used. The track is laid with 80-lb. T-rail. The third rail is raised six inches above the track, and is supported every ten feet by wooden blocks. Over these blocks are fitted malleable cast-iron caps or chairs, on which the rail rests. The third rail contains less carbon than the other two, with a view to reducing its electrical resistance. Contact with the rail is made by shoes, of which each car carries four, two on each side. These shoes are 31 feet apart, and are arranged in this way in order to meet the interruption of the third rail at farm and road crossings. The shoes are let up or down, swivel fashion, according as current is required or not. The trains are capable of travelling at 50 miles an hour. The article contains several drawings, showing the designs of the station and substations, and the connections on the various switchboards. A drawing showing the construction of the contact-shoe and the lifting mechanism is given in an article in the Electrical World and Engineer of December 8, 1900, and a short description of the line appeared in the Electrician of December 28, 1900. W. H. S

1433. *Hoboken Power Station.* (Elect. World and Engineer, 37. pp. 467–470, March 23, 1901.)—The description of the station at Hoboken, of the United Electric Company of New Jersey, is of some interest as an example of changing-over. The whole of the belted plant has been replaced by direct-connected units of the most modern practice, and the e.m.f. has been raised from 1,040 to 2,400 volts without shutting down any circuit. The chief plant consists of General Electric railway generators of 850 kw. at 90 r.p.m., and Stanley two-phase alternators giving 2,400 volts at 60 ∿ and capable of a load of 1,050 kw. for three hours. For arc lighting there are four 150 kw. 2,400-volt synchronous Stanley motors, each direct connected with two 125-light 2,000 c.p. Brush machines. The connection between the motors and dynamos is made by means of a flexible coupling, consisting of a four-arm spider on each motor and dynamo shaft, connection between them being made by leather links. Each motor is brought up to synchronism by a 15-h.p. Sprague motor. The connection between the synchronous motor and the starting motor is made by means of a raw-hide intermediate pinion secured to a lever so that it can easily be thrown in or out of gear. Descriptions are given of the several switchboards. One of the panels of the alternating current board is employed for supplying current to two 100-kw. step-up transformers connected on the Scott system for supplying the Jersey City station with 6,600 volt three-phase currents; at the receiving end the current is stepped down to 2,400 volts two-phase.



A "jumper" device designed by H. D. King is described. By its means connection may be made in a few seconds between one switchboard panel and another in case of accident. It consists of three castings. The main part A is, as shown, intended to be clamped to a cable, and is provided with the lugs *a* and a^1. The inner surfaces are bevelled, and when the portion B is slipped over the projecting stud *b* and given a quarter turn, the prepared surfaces are brought together and a good contact ensured. The B end of the "jumper" cable is then connected to any desired panel in a similar manner. W. W. H. G.

1434. *Transmission at the Cochiti Gold Mines at* 20,000 *volts.* **F. W. Hart.** (Elect. World and Engineer, 37. pp. 345–349, March 2, 1901.)—Owing to the impracticability of getting sufficient fuel at the Cochiti Gold Mines, near Bland, in Mexico, electrical plant was put down at coal mines 32 miles distant. The total cost of supplying power with the old steam plant, using cord-wood as fuel, and hoisting and milling 200 tons per 24 hours, was $218 per diem. The cost of doing the work now with electric power generated and transmitted 32 miles is $52.75 per diem for hoisting and treating 300 tons. These figures do not include interest or depreciation on either plant. Feed-water at the coal mines is obtained from artesian wells, and contains 38 per cent. of incrustating solids, but boilers are carefully inspected and cleaned every eight days, and give no trouble. The power-house will contain two General Electric three-phase, revolving-field type, 605-volt, 60-cycle generators, direct connected to Allis-Corliss engines, running at 90 r.p.m., having fly-wheels 20 feet in diameter, weighing 70,000 lbs. Only one of these units is installed at present. The commercial efficiencies of the generators, not including friction losses, are 93 per cent. at full load, non-inductive; 92 per cent. at three-quarter load, non-inductive; and 89 per cent. at half load, non-inductive. There are two 125-volt compound-wound exciters, one steam-driven and the other motor-driven. A third will be added. Three step-up transformers of 200 kw. each, of the vertical air-blast type, transform a voltage of 605 to 20,000, and have a full-load efficiency of 97 per cent. The switch-board has two sets of bus-bars, double-throw oil switches, expulsion fuse blocks, &c. The 20,000 volt switches are of the knife-blade type, and they, as well as the expulsion fuse blocks, are provided with large marble barrier plates. The boiler equipment consists of two batteries, each consisting of three 175-h.p. return tubular boilers, built for 125 lbs. working pressure. This type of boiler was used on account of the bad feed-water. Coal is fed from a weighing hopper direct into a Jeffrey conveyor, which delivers it into steel coal bins above the boilers, the bins having a capacity of 100 tons. Thence it is drawn through spouts at convenient points in front of each boiler. A coal crusher is provided, so that, in case the supply of slack is not sufficient for the demands of the plant, "mine run" can be handled. An ash conveyor delivers the ashes into a storage hopper, from which they are drawn into a steel ash-car. With this coal and ash arrangement, one man per shift easily does the firing. The coal crusher and ash and coal conveyor are each driven by a 10-h.p. induction motor. The pole line is designed to eventually carry two circuits of No. 4 wire, the three wires of each circuit being placed at the points of an equilateral triangle, the distance between wires being 24 inches. A telephone circuit of No. 12 hard-drawn copper is placed 5 feet below the power circuits. The power circuits are transposed every half mile, the telephone every five poles. No difficulty is experienced from inductance on the telephone circuit. The poles on the line are spaced 100 feet apart, and vary in length from 20 to 40 feet. Glass insulators of the Provo type, manufactured by the Hemingray Company, were used mounted on special locust pins which were boiled in paraffin. The cross arms are of Oregon fir, and angle-iron cross armbraces were used. Great care was exercised in the erection of the line, and up to the present time there has been no interruption of the service due to line trouble. The energy loss in the line when delivering 600 kw. to the mine is 8·5 per cent. At the receiving end of the line are three 180-kw. transformers of the vertical air-blast type, reducing the potential from 18,500 volts to 605. This apparatus is placed in a fireproof building with the electric hoist and a motor-driven air compressor of the Sargent-Ingersoll type 22¼ by 14¼ by 18 in., fitted with air regulator, and operated by a 150-h.p. induction motor. The receiver pressure is 90 lbs. The electric hoist is a double drum, and is arranged so that cages can be run balanced or independent as desired. The drums each carry 1,000 feet of 1-inch rope, and the rope speed is 840 feet per minute. The shaft has a slight incline. The weight of the cage is 1,762 lbs., and of the loaded car 1,825 lbs. A 100-h.p. induction motor is geared to the hoist by means of a raw-hide pinion and operated at 450 r.p.m. By means of a controller the resistance in the secondaries can be varied, and direction of rotation reversed, and no sudden jerk is experienced in starting the cage. Three hundred and fifty tons of ore per day of 20 hours can be readily handled with this hoist from a 500-feet level. The crushing mill is in two sections, each section forming a complete mill for crushing, rolling, drying, and screening ore to 40 mesh, a 150-h.p. motor being belted to each section. The mill when treating 350 tons of ore per day requires a maximum of 230 h.p., this amount varying slightly with the character of the ore. The motors at the receiving end of the line are: One 150 h.p. for compressor, one 100 h.p. for hoist, two 150 h.p. for mill, one 20 h.p. for sawmill, two 20 h.p. for Peletin tanks, one 10 h.p. for solution pumps, one 10 h.p. for machine shop, one 1 h.p. for transformer blower, 10 h.p. for lights, making a total of 621 h.p. At the generating end the motors are: One 20 h.p. for motor-generator set, one 10 h.p. for coal conveyor, one 10 h.p. for ash conveyor, one 10 h.p. for coal crusher, one 1 h.p. for transformer blower.

At the pump-house, 14,000 feet from the power-house, there are two 10-h.p. motors running at 450 r.p.m., geared to triplex feed-pumps for forcing water up to power-house, and one 1-h.p. motor belted to an artesian deep well pump. This makes a total of 702 h.p. in induction motors. They are all supplied with oil switches and expulsion fuse blocks. The plant is for continuous service with an hour's stop for adjustment on Sundays.

E. H. C.-H.

1435. *Electric Power in the Olympia Mills.* (Eng. Record, 43. pp. 317–321, April 6, 1901.)—Two sets of plans were drawn up for this cotton mill, one suitable for electric-power distribution, the other for distribution by belts and shafting throughout. Tenders were obtained upon each, and the electric system proved the cheaper. It saved 10 per cent. on the mill buildings by the absence of the heavy transverse walls necessary with belts and shafting, 61 per cent. on shafting, and 66 per cent. on ropes and belts. The saving on these three items was more than sufficient, it is stated, to pay for the electrical equipment of the mill. The power is obtained from three three-phase generators, each of 1,300 kw. capacity, direct-connected to a McIntosh & Seymour engine of 1,600 i.h.p., and is distributed by means of induction motors through the mill. The paper contains a full description of the plant and the considerations that led to the adoption of the electric system of power distribution.

J. H.

1436. *Electricity Works of the Virginia Electrical Railway and Development Company, Richmond, Va.* (Elect. Rev., N.Y., 38. pp. 124–130, Jan. 26, 1901.)—The final equipment of the power-house will consist of eleven generating units, of which four are at present installed. These units consist of two 51-inch cylinder gate horizontal shaft turbines coupled to a 750-kw. direct-current 550-volt dynamo and an Allis tandem compound steam-engine rated at 700 h.p. A complete auxiliary steam plant is a necessary feature, although it is not thought that it will be required more than one month in the year under normal conditions. The balancers, booster, switchboard, feeder cables, &c., are described.

E. K. S.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1437. *Sag and Strain in Trolley Wires.* **B. Hopkinson.** (Electrician, 46. p. 501, Jan. 25, 1901.)—Dawson has stated that a trolley wire of No. ^{0}. B. & S. gauge should be so hung that the tension shall never, under any temperature that is likely to occur, exceed 2,000 lbs., corresponding to a sag of 3·8 inches on a span of 125 feet. If, therefore, the sag is 12 inches at 50° F. the wire will become dangerously tight if the temperature falls below the freezing-point. Wires are, however, generally put up tighter than this would imply. At Leeds on spans of 120 feet the sag in several cases was found to be as small as 8 inches, with a temperature of 50° F., and tighter spans are not uncommon. The author considers that this discrepancy between theory and practice is due probably to neglect of the elastic extension of the wire. Ewing found that with hard-drawn copper its natural length changes by 0·00085 per cent. per degree Fahrenheit, and that it stretches by nearly $\frac{1}{1000}$th part of its length for every 1,000 lbs. of tension up to 3,500 lbs., when the elasticity becomes imperfect. The following table has been calculated for a wire 0·4 inch in diameter, the supports being 120 feet apart. The actual length of the wire is s when hung at a temperature of t° F.; s' is the unstretched length of the wire; l is the distance between the supports. The second column is calculated from the catenary given by the first, the tension depending only on the weight of the wire. The third column gives the ratio of stretching by virtue of the tension; the fourth is calculated from the properties of the catenary. The sixth column is the expansion of the wire due to rise of temperature in hundred-thousandths of its length. The last column is the temperature calculated from the expansion shown in the sixth. This table shows that wire hung so that the sag on a span of 40 yards is 6 inches at a temperature of 60° F. will never in this country be stretched beyond the limit of elasticity. The tension at 25° F. will be 2,400 lbs., and the sag 4½ inches; at 107° F. the sag will only be 9 inches. W. H. S.

Sag. in.	Tension lb.	s/s'.	s/l.	Natural Length. (s'/l.)	Expansion due to Temperature (t.)	Temp. (t.)
3	3,600	1·0018	1·00001	1 — (0·0018)	0	0°
4½	2,400	1·0012	1·00002	1 — (0·0012)	60	70°
6	1,800	1·0009	1·00004	1 — (0·0009)	90	105°
9	1,200	1·0006	1·00010	1 — (0·0005)	130	152°
12	900	1·00045	1·00018	1 — (0·00027)	153	180°
18	600	1·0003	1·00041	1·00011	191	220°

1438. *Rating of Tramway Motors.* **A. H. Armstrong.** (Street Rly. Journ. 17. pp. 289–292, April, 1901.)—The author deals with the matter from a somewhat different point of view from that taken by Storer. [See Abstract No. 984 (1901).] He argues that it is only possible to arrive at satisfactory conclusions with regard to the performance of any motor after making careful observations on the motor under actual working conditions. The results obtained will depend partly on the length of the runs, and therefore indirectly on the number of stops per mile, partly on the efficiency of the ventilation, and partly on other circumstances peculiar to the various cases. He therefore advocates a very careful examination of motors of the different types with a view to arriving at general conclusions. His method of testing is somewhat complex, but may be summarised as follows. He first constructs so-called acceleration curves, which have the time elapsed from the start of the car's run for abscissæ, and for ordinates (1) the speed attained in miles per hour; (2) the amperes taken by the motor; (3) the total distance travelled; the speed curves being also completed so as to show the effect of coasting and braking with a view to bringing the car to a standstill in a given distance. A second set of curves is then constructed, having again the time elapsed for abscissæ, and for ordinates the average losses which have taken place during the various times in the armature and field, and also the ratio of the said losses in the said times. Having by observation determined the temperature rises in armature and field in the various times, he deduces the temperature rises per watt loss both in armature and field. Curves are then drawn showing the relation between the temperature rise per watt loss both in field and armature and the ratios of the losses in armature and field; and it is pointed out that in an enclosed motor the interchange of heat between the field and armature is a matter for serious consideration. Finally a fourth set of curves is constructed showing the relation between the number of stoppages per mile and the number of tons a given motor will carry, the schedule speed maintained being also shown, and a temperature rise of 60° C. being allowed. In this way the author maintains that it will be possible to predict the results which a given type of motor will show under known working conditions, and considers that this method is far better than any form of workshop test. The figures and curves contained in the article were furnished by the General Electric Company of America, and were taken from tests made by them on their experimental track along the Erie Canal. The author in conclusion deals with the errors which may arise from the various forms of workshop test, and in particular from those advocated by Storer in the article already referred to. W. H. S.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

1439. *Rosenfeld and Zelenay System of Electric Traction.* **L. Gerard.** (Soc. Belge Élect., Bull. 18. pp. 55–68, Feb., 1901.)—This system, which has been devised by two engineers of the Société "Electricité et Hydraulique" is called by them "tangential traction." It can only be operated economically on very high speed railways, the trains running at least 60 miles an hour. For speeds below this, the system is unsuitable, and would be very costly. It may briefly be described as follows. In addition to the ordinary rails, a second pair of light and insulated rails is laid between them, about 27 inches apart. Along the centre of the line rectangular blocks of laminated iron are fixed in the ballast at intervals of 55 yards. The length of each block is 11 yards. The blocks are arranged at a certain distance apart owing to the prohibitive cost of a continuous series. These blocks are wound with a three-phase winding, and may be regarded as constituting the stator of an induction motor. What corresponds to the rotor is a similar block of laminated iron, fixed on the axles of a truck that runs on the insulated rails, the said truck being beneath the main body of the car, and attached to it by hooks and chains. The winding of the rotor block is under the control of the driver, who can insert resistances at will. The air-gap between the rotor and stator is about two-fifths of an inch. The authors assert that an asynchronous triphase motor with an air-gap of this size has an efficiency of about 85 per cent. When, therefore, the stator blocks are excited by current from the

power-house, they exert a horizontal pull on the rotor blocks, which sets the train in motion. The propelling force on the train becomes practically very small unless the rotor block is immediately over a stator block, and the driving force is applied in jerks and not continuously. The loss of power that would be entailed by keeping the whole of the stator coils excited is obviated by dividing the line into sections of 550 yards, and exciting that section only on which the train is passing, the switching being done automatically by the train. The author gives an estimate for running trains at high speeds on this system, and according to these figures the system would be cheaper than the ordinary continuous current system. An experimental line is to be constructed.
J. H.

1440. *Behr High-speed Railway.* **F. J. Behr.** (Soc. Arts., Journ. 49. pp. 305–312; Discussion, pp. 312–314, March 15, 1901.)—The author gives a description of the mono-rail line laid down by him at the Brussels exhibition, and then gives details of the proposed Manchester-Liverpool line, dealing more especially with the systems of signalling and braking. [Abstract Nos. 307 and 308 (1901).] *Discussion:*—**Carus-Wilson** criticised the brake, maintaining that it was impossible to obtain a retardation of 8¼ feet per second per second, which would stop the train in 500 yards; the resistance to slipping on the rail at this retardation would have to be 600 lbs. per ton. He considered the practical limit to be 320 lbs. per ton, which would enable a retardation to be obtained of about 4¼ feet per second per second. **A. Cunningham** thought that on curves a tilt in the line was necessary for the comfort of passengers. **W. S. Boult** believed that considerable difficulty would be found in making the signalling contacts with the train at a speed of 110 miles per hour. **T. Carter** considered that the air resistance would contribute a considerable factor to the braking power. The author, in reply, said that according to his calculations the braking power required would not be nearly so much as that mentioned by Carus-Wilson. It might be found desirable to slightly tilt the rail, but on the Brussels line no discomfort was caused round curves of 540 yards at a speed of 85 miles per hour, and on the proposed line the smallest curve was 750 yards. The signalling contacts would be from 100 to 200 feet long, and had been designed for high speeds.
G. H. B.

1441. *Breakdowns on the Berlin Tramways.* **J. Zacharias.** (Centralblatt Accumulatoren, 1. pp. 107–108, 1900.)—The heavy falls of snow last winter having occasioned breakdowns on the Berlin tramways, Albrecht, in the Elektrotechnische Anzeiger, attributes them to the use of Planté-type cells, and considers that pasted cells would be better suited to the mixed system employed in Berlin. The present article is a reply to Albrecht's, and endeavours to show that pasted plates could not be used under the conditions obtaining in Berlin, and attributes the breakdowns to the very great variation of pressure which occurred at the time of the snowstorms, the voltage on some days being so low that it was not possible to charge the cells.
G. H. B.

1442. *Automatic Electric Block Signals on the Hungarian Southern Railway.* **O. Ehrenfest.** (Elektrotechn. Zeitschr. 22. pp. 216–220, March 7, 1901.)—In this system, the signals at each post are actuated by a weight motor, which has to be wound up twice a day by a signalman. The motion of this motor is controlled by two electromagnetic detents, one actuated by alternate currents from a signal-box to set the arm to "line clear," while the other, actuated by a continuous current in a circuit completed by the train, sets the signal to danger. Photographs of the apparatus and a diagram of connections are given in the original paper. C. K. F.

1443. *Electric Platform at the Paris Exhibition*, 1900. **Jovignot.** (Soc. Int. Élect., Bull. 1. pp. 9–58, Jan., 1901.)—After outlining the history of moving platforms, the author describes the conditions under which the platform was constructed. The number of passengers provided for was 30,000 per hour; the main platform moved at the rate of 9 km., and the auxiliary at 4·5 km. per hour, and the total circuit was 3·37 km. in circumference. The structure was carried at a height of 7 m. on wooden piles with cross girders. The platforms consisted of two articulated chains of trucks, of which there were 1,700, carried by wheels running on steel rails; part of the weight was borne by a central girder running on wheels, of which 172 were motor-driven. The weight per metre of the 9-inch platform was 325 kg. light, and 885 kg. loaded; of the slow platform 150 and 290 kg. Various details of the electrical equipment are given; direct current was adopted, at 500 volts, the motors being of 5 h.p. each at 725 r.p.m., and having an efficiency at full load of 85 per cent. The distributing cables were calculated for a power of 600 kw. uniformly distributed, with a total loss of 8 per cent., requiring 42 metric tons of copper; the actual power was found to be 200 kw. Power was supplied through a substation containing two direct-current generators of 600 kw. each, coupled to three-phase 5,000 volt induction motors, with the necessary adjuncts.

On first starting the platforms, it was found necessary to divide the distributing cables into two equal lots, and to couple the motors two in series; as the speed was found to be sufficient, this arrangement was permanently retained, though the starting and running effort rapidly decreased with use. The platforms were operated successfully for 210 days, traversing nearly 19,000 km.; they cost 1,000 fr. per metre, inclusive, and transported seven million passengers in seven months. The total capital cost was 240,000 fr., and the running cost 180,000 fr. Full details of the construction are given in the paper, with particulars of the results obtained in working. A. H. A.

1444. *Electric Traction on Canals.* **L. Gerard.** (Soc. Belge Élect., Bull. 18. pp. 23–36, Jan., and 73–82, Feb., 1901.)—The author gives numerical data relating to various systems of electric traction, in tabular form, calculating the efficiency as the ratio of the power actually developed in the tow-rope to the electrical power applied. The Köttgen rack system on the Finow canal showed a maximum efficiency of 0·704 when towing a 100-ton barge at 3·75 km. per hour, the tractor working up to 20 e.h.p. at most, with an expenditure of 5¾ e.h.p. running light at 7·5 km. per hour. The Denèfle tricycle (old form) on the Aire and Deule gave an efficiency of 0·414 when towing a barge of 293 tons at 2·8 km. per hour, with a maximum power of 19·2 e.h.p. Running light at 3·74 km. per hour, the tricycle took 4·17 h.p. A new pattern of the tricycle gave an efficiency of 0·44 with the same load, at 2·64 km. per hour. The Gerard tractor gave 0·534 at 3·6 km., towing two 70-ton barges, and took 5·5 h.p. at 4·4 km. empty. Figures are given relating to the power absorbed by road friction. The Gerard screw-propeller system gave an efficiency of 0·322 at 3·2 km., the screw making 375 revs. per minute when towing two 70-ton barges, and took 5·4 h.p. at 8·2 km. empty. This result is compared with steam practice, for which a maximum efficiency of 0·294 is given.

Discussing the figures given, the author points out that the cost of maintenance of the banks and of the tractors will in many cases more than outweigh the low efficiency of the electric towage system, while in addition the banks are often unfit to bear the weight of the tractors. Where these considerations do not hold, the rack system is the best, except for low speeds and loads, which are best handled by tractors without rails. The effect of the section of the canal and the strong influence of the current along it are next dealt with, and the very important question of the state of the tow-path is considered in detail; the loss due to rolling friction may amount to 35 per cent. By comparing figures obtained with animal haulage with those of electrical haulage, an increase of over 42 per cent. in the voyages annually made by a barge is shown in favour of the latter. In conclusion, the advantages gained by the electrical distribution of energy along the line of the canal, for lighting, pumping, dredging, and motive power in general, are emphasised. A. H. A.

1445. *Cleveland Electric Car.* (Automotor Journal, 5. pp. 267–269, March, 1901.)—A battery of 40 storage cells, each weighing 22 lbs. and of 130 ampere hours' capacity, supply the motive power to a 2 h.p. bipolar motor weighing 155 lbs. and running at 1,800 revolutions at 80 volts. The motor is normally connected to the axle of the driving wheels through a double reduction gear, but for hill climbing an extra reduction acting somewhat similarly to the back gear of a lathe can be introduced. Three speeds are obtained by coupling the cells four in parallel, two in parallel, or all in series, and then still higher speeds by shunting more or less of the field-magnet current. An electric brake effect is also provided for by a variable resistance through which the armature can be short-circuited. Diagrams of the electrical connections, and drawings showing the details of the transmission gear, are given. E. J. W.

1446. *Electric Motor-Car Trials.* (Electrician, 46, pp. 669–670, Feb. 22, 1901. See also Elect. Rev. pp. 388–390, March 1, 1901.)—This is the judges' report on the Automobile Club's trials at Chislehurst, and contains the results of the various observations.

The unanimous opinion of observers was that recuperation of cells downhill amounted to very little in practice. Considerable currents were returned, but for such short intervals that the saving of energy was practically nil. Indirectly, however, recuperation is of advantage to those batteries which tend to become polarised. E. H. C.-H.

1447. *Electrically-Driven Fire Cart.* **M. Schiemann.** (Centralblatt Accumulatoren, 2. pp. 79–81, March 1, 1901.)—The author has made a cart for conveying the first five firemen to a fire. Its tare is 1,000 kg. without its 600 kg. of battery, which will carry it for 15 km. in one hour. It is driven by a 4-h.p. motor, running at 1,500 r.p.m., driving a double bevel gear, which in turn drives the split front axle. The back axle is used for steering by means of a chain and quadrant. The average amount at 15 km. per hour on asphalt or macadam is 47 amps., at 85 volts (44 cells), which is equivalent to 0·13 kw.-hours per ton-km. The efficiency of the vehicle is 35 per cent. Another cart described will run at 20 km. per hour on the level. Each axle is driven through spur gearing by a motor, and can be moved separately on curves.

Both axles run and turn on ball bearings. The cart with motors weighs 4,000 kg., and the cells 1,500 kg., while fire apparatus, &c., will bring the total loaded weight up to 7 tons. Taking the traction-coefficient as 30 kg. per ton, the motors at 20 km. per hour must give about 20 h.p. or 14 kw. Each is rated at 9 h.p., or 12 h.p. maximum. The accumulators have 14 kw.-hours capacity, and the cart can go 20 km. in one hour. Allowing for battery inefficiency, the charge required is 21 kw.-hours, which at 10 pfg. per unit costs 2·10 Mk.; it will then go 20 km. at 20 km. per hour. Such a vehicle costs 12,000 Mk. Assuming that it makes 200 journeys a year of an average length of 5 km., the annual cost is:—

Interest, 5 per cent on 12,000 Mk.	600 Mk.
Depreciation and renewals, ditto	600 Mk.
Materials for repairs (labour being supplied from the ordinary fire staff)	500 Mk.
Maintenance and renewal of the battery, assuming 50 complete discharges per annum, say 20 per cent. of purchase price (3,400 Mk.)	680 Mk.
Cost of current, ($\frac{1000}{20} \times 2·10$ Mk.)	105 Mk.
Battery losses when standing idle, say 15 per cent ...	15 Mk.
Total ...	2,500 Mk.
or 2·5 Mk. per km. run,	

which compares very favourably with horse traction. The Paris fire brigade has a complete equipment of electrically driven fire carts. Altona and Berlin have trial vehicles. E. H. C.-H.

1448. *Still Electric Vehicle.* (Automotor Journal, 5. pp. 261–263, March, 1901.)—The chief peculiarity of the vehicle is the manner in which the motor imparts its energy to the driving wheels. It is elastically suspended from a frame which is itself fixed across the centre of the main framework of the carriage. Both the field magnets and the armature revolve on ball bearings, and each of these parts is connected with a projecting shaft, terminating in a chain wheel. The one chain wheel is connected by a chain with the one driving wheel in the usual way, but on the other side of the vehicle the chain passes round the underside of the chain wheel and is carried by an idle wheel in front of it. Although the two motor shafts revolve in opposite directions both rear wheels are thus driven in the same direction. The motor is entirely enclosed as bipolar, and sliding contact rings and brushes are used for making the electrical connections to the revolving field magnet. It is series wound and the field magnet windings are divided into two parts, having different resistances. The armature has 30 sections and is of the slotted drum type. The weight of the 3 h.p. motor is 100 lbs., and the relative speed of the armature and field is 1,000 r.p.m when the vehicle is running at 12 miles an hour. The system of control which is employed consists in placing the battery in series, or in two parallels, and also in weakening the field by short-circuiting its higher resistance winding. Four speeds are in this manner obtained. The controller has two interlocking drums, one of which reverses the armature connections and the direction of rotation of the motor. The accumulators are known as the "Ideal" and are of the pasted lead type; drawings of these are given, and the capacity is said by the makers to be as high as 10 watt-hours per pound at a five-hour rate of discharge. A sectional drawing of the motor, and a diagram of the controller connections also accompany the description. A. G. N

ELECTRIC LAMPS AND LIGHTING.

1449. *Dick's System of Railway-train Lighting.* **E. Dick.** (Zeitschr. Elektrotechn. Wien, 19. pp. 78–80, Feb. 17; 89–95, Feb. 24; 101–104, March 3; and 115–117, March 10, 1901.)—This system is adapted for lighting single carriages, and is apparently a development of that described in Abstract No. 1416 (1898). It is shown fitted to a bogie carriage, from one of the axles of which the dynamo is driven through enclosed spur-gearing (speed-ratio = 1 : 3), whilst the accumulators are arranged in boxes suspended from the underside of the car-body. When the speed of the train exceeds 20 kilometres per hour the dynamo supplies the whole of the current for the lamps and charges the accumulators; at lower speeds the accumulators supply the current for the lamps. The dynamo is 4-pole, of the ironclad type, and gives 30 amperes and 45 volts at speeds varying from 400 to 1,600 r.p.m., corresponding to speeds of from 23 to 93 kilometres per hour of the train. The controlling switch for cutting the dynamo into and out of circuit with the lamps was described in Abstract No. 708 (1901), whilst the regulating switch for cutting resistance into and out of the field magnet circuit to keep the potential difference constant is described in Abstract No. 1156 (1900). Relays are also provided, one for altering the sensitiveness of the pressure regulator when the accumulators are charged, and the other for reducing the loss of energy in the field-magnet circuit of the dynamo to a minimum when the train is not in motion. A switch is also provided for putting both accumulator batteries in parallel when the lamps are not in circuit so that the two batteries can be charged simultaneously, and for enabling one battery to be charged whilst the other is used as a pressure-regulator when the dynamo is supplying current to the lamps. The two batteries each consist of 18 elements, and are of a combined capacity sufficient to light the lamps for six hours without the aid of the dynamo. The accumulators are of the Wehrlin type in which measured amounts of active material are pressed, in a machine, into pastilles having a large number of perforations. These pastilles are first dried in the air and then in a stove, after which they are put into a mould and hard lead cast around them to form a grid. The plates are built into ebonite cells having ebonite covers. Nine of these elements are combined in a wood receptacle to form a half-battery, of which four are used in each carriage. After giving a detailed description of the operation the author gives the initial cost per carriage as follows: Dynamo and gearing, 1,800 crowns; switches, fuses, and resistances, 1,200 crowns; batteries, 1,120 crowns; 14 roof-lamps, 470 crowns; conductors and installation, 320 crowns, making a total of 4,910 crowns. The running expenses are as follows: Depreciation and interest at 7 per cent., 343·7 crowns; maintenance, 173·15 crowns; working expenses, 213·15 crowns, making a total of 730 crowns per annum. A similar estimate is made for local trains in which there is a dynamo at each end of the train and 56 lamps. In this case, the initial cost works out at 13,560 crowns, and the running expenses per annum are 1,900 crowns per train, or 135·74 crowns per carriage.

C. K. F.

REFERENCES.

1450. *The First Public Electromobile in Vienna.* **E. Dieudonné.** (Locomotion Automobile, 8. pp. 105–106, Feb. 14, 1901.)—A general description, together with an illustration, of this vehicle (a Victoria). Sixteen more of these are to be put at the disposal of the public shortly.

A. G. N.

1451. *Glow-Lamp Shades and Globes.* **W. L. Smith.** (Technology Quarterly, 13. pp. 176–223, 1900.)—This paper, after some rather valuable remarks on the lighting of rooms, &c., deals with the distribution of light of lamps fitted with 24 different forms of shades or globes. It is profusely illustrated with polar diagrams of the light distribution with the different forms, as obtained from photometric observations. E. C. R.

1452. *Advantages of Electric Traction.* (Union Int. Permanente de Tramways: Questionnaire, 1900, pp. 16–25. Comptes Rendus (International Tramway Congress at Paris), 1900, pp. 35–36 and 135–142.)—Figures of cost and receipts are given by various tramway companies for horse traction and for electric traction on the same lines before and after transformation. The matter forms the subject of a report by **E. de Pirch.** W. R. C.

1453. *Telpherage.* (Eng. News, 45. p. 105, Feb. 7, 1901.)—A brief description of the installation at the works of the Crocker-Wheeler Co., New Jersey. A. H. A.

1454. *Lighting of the Thames Embankment.* (Electrician, 46. pp. 689–692, March 1, 1901.)—A description of the arc lighting installation, driven by gas engines. A. H. A.

1455. *Electric Power at the Paris Exhibition.* **R. V. Picou.** (Soc. Int. Élect., Bull. 1. pp. 120–145, March, 1901.)—This paper deals with the generation and distribution of power within the exhibition buildings.

1456. *Electric Traction Experiments on the Belgian State Railways.* **E. Gerard.** (Soc. Belge Élect., Bull. 18. pp. 91–124; Discussion, pp. 124–126, March, 1901.)—A very full description of the preliminary electrical work which has been carried out on the Belgian State Railways, and the success of which has decided the Government to use electric traction on the whole of the Belgian railway system. Full particulars are given of the 100-h.p. gearless motors made by the International Electric Co., of Liège, and others; also of the controllers, accumulators, &c. E. K. S.

1457. *Calculations of Networks.* **J. Teichmüller.** (Elektrotechn. Zeitschr. 22. pp. 229–231, March 14; 249–255, March 21, and 271–273, March 28, 1901. Paper read at the Kiel Meeting of the Verband Deutscher Elektrotechniker.)—The necessary calculations to determine the size of cables for electrical distribution are considered from fundamental principles and general formulæ are deduced. The paper concludes with an example applied to the installation at the Carlsruhe Technical High School. W. W. H. G.

1458. *Electric Lamps.* **E. de Fodor.** (Zeitschr. Elektrotechn. Wien, 19. pp. 165–168, April 7; and 180–183, with Discussion, pp. 184–185, April 14, 1901. Paper read before the Elektrotechn. Verein, March 6, 1901.)—This paper is mainly historical, dealing however in part with some of the latest developments, such as the Auer osmium lamp, the Nernst lamp, and Rasch's electrolytic arc lamp. W. H. S.

1459. *Value of Earthing.* **F. Uppenborn.** (Elektrotechn. Zeitschr. 22. pp. 370–372; Discussion, pp. 372–373, April 25, 1901.)—A paper read before the Verband Deutscher Elektrotechniker. W. W. H. G.

1460. *Electrical Power Bills of 1900.* **W. L. Madgen.** (Inst. Elect. Engin., Journ. 30. pp. 475–497; Discussion, pp. 497–508, and 514–539, April, 1901.)

TELEGRAPHY AND TELEPHONY.

1461. *Baudot Multiple Type-printing Telegraph.* **Grallert.** (Elektrotechn. Zeitschr. 22. pp. 282–293; Discussion, p. 293, March 28, 1901. Paper read before the Elektrotechn. Verein, Feb. 26, 1901.)—The author describes the Baudot telegraph as in use for the Paris and Berlin service for quadruple working. Its principle is as follows. Two distributing arms, rotating sychronously, one at the sending and the other at the receiving station, pass over four sets of five contacts; each set is in connection with a separate instrument, but it will be sufficient to consider one set only. The five contacts are electrically connected to five keys at the sending end, and to five electromagnets at the receiving end. The signals, corresponding to letters, consist of the 31 different combinations possible with the five keys—that is, to different combinations of five or less currents sent successively along the line; two change signals shift the type-wheel on the receiving instrument so as to print either letters or figures for any one signal, so that in all 58 different signals can be printed. The five electromagnets at the receiving end arrange five feelers, according to the combination signalled over the indented edges of two wheels fixed on the axis of the type-wheel, and continually rotating with it; at a certain point each feeler is over an indentation in one or other of the wheels, and all five sink together, thereby releasing a mechanism which presses the paper against the type-wheel and prints the letter corresponding to the signal. At the sending end the keys must be pressed exactly at the moment at which the rotating distributing arm begins to pass over the five contacts corresponding to the keys; to assure this an audible signal is given by a sort of telephone to indicate the correct moment for signalling; this is given by an extra contact inserted before each group of five, the distributer having therefore 24 contacts. As the contact arms make three revolutions per second, the time of any one current impulse is only $\frac{1}{72}$ second; the receiving relay must, therefore, be extremely sensitive and quick in action; it is a polarised relay of somewhat novel design, and is fully described in the paper with three drawings. The five electromagnets of the receiver act on five levers turning on five parallel axes; one end of these constitute the feelers which rest on the periphery of one indented wheel; the other ends are headed to bear one against the other in such a way that no feeler can sink into an indentation unless all five sink together. The electromagnets act on the levers in displacing them laterally, so that the feelers are transferred to the second indented wheel; indentations on one wheel correspond to projections on the other. Corresponding to each signal, that is, to each arrangement of the five feelers over the two wheels, is one position of the wheels, and with them of the type-wheel, in which an indentation is below each feeler, so that all can sink together; the sinking of the feelers releases a cam which presses the paper against the type-wheel and moves on the paper; a certain fraction of the periphery of the wheels is free from indentations, and is occupied by a snail which returns the displaced feelers to the wheel on which they normally rest. The periphery of the type-wheel is occupied (except on the corresponding portion left free) by 31 letters alternating with 31 figures, &c., and the change from letters to figures, and *vice versâ*, is effected by shifting the type-wheel relatively to its axis which carries the indented wheels, the shifting being done by the cam which moves the paper. The distributor arm and the type-wheel at the receiving end are regulated to turn slightly faster than the sending distributor, and they are kept in synchronism by a brake applied by an electromagnet, which once in every revolution receives a correcting current if the arms are out of synchronism. The first regulation of speed is effected by a centrifugal governor acting on a brake. The distributor for single, duplex, and triplex telegraphy consists of six contact rings arranged on a single disc, while in quadruple and sextuple telegraphy two discs with ten rings are required. Three pairs of brushes rotate over each disc, each pair making contact between two contact rings. One disc is capable of a slight displacement relative to the other, to allow for the delay occurring between the line current and the consequent action of the printing magnets, due to the self-induction and inertia of the various relays in circuit. The disposition and connection of the contacts are very fully described in the paper, but cannot be dealt with in an abstract; they are arranged to work for sending and receiving, for the two brakes and for the signal. The paper contains a minute description of the whole instrument with 47 diagrams. G. H. B.

1462. *Burry Page-printing Telegraph.* (Scientific American, 84. pp. 181–182, March 23, 1901.)—The feature of this apparatus consists in that the characters are printed in horizontal lines across the paper as on a typewriter. This is effected by means of five electromagnets arranged in two circuits, through which currents can be passed in both directions by means of suitable reversing keys in the transmitter [not described]. One of these magnets serves to wind up springs for rotating the type-wheel, for traversing the carriage bearing the type-wheel, and for effecting other operations. The other electromagnets control escapements for permitting the step-by-step rotation of the type-wheel and the traverse of the type-wheel carriage, and for actuating the paper-feed, consisting of an aligning device, consisting of a V-shaped tooth pressing into the spaces of a star-wheel, an impression device for bringing the paper into engagement with the type-wheel, and other mechanism. The original paper is illustrated, but more complete drawings and description will be found in the specification of British patent No. 19824 of 1900. C. K. F.

1463. *Selective Wireless Signals.* **P. Jégou.** (Comptes Rendus, 131. pp. 882–883, 1900.)—Two antennæ of different lengths are erected at the receiving stations and convey the waves to two coherers supposed to be of equal sensitiveness. By means of a differential bobbin the windings of which are respectively connected to the two receiving coherers, the effects on the galvanometer neutralise one another when both antennæ act, and are only noticeable when one coherer is affected. M. O'G.

1464. *Wireless Telegraphy.* **F. Braun.** (Electrician, 46. pp. 778–779, March 15, 1901.)—This paper is a summary of two lectures delivered by the author at Strassburg on November 16, 1900, and January 31, 1900. The author describes a method devised by himself of exciting the transmitter by induction. Condensers with a capacity of the order of the usual size of Leyden jar are discharged through a primary circuit with self-induction; this circuit excites oscillations in the lower spirally wound end of the transmitter. The transmitter is insulated from the earth, and is sparkless. The author claims the following advantages: (1) In the primary circuit a large amount of energy can be employed usefully; the action of the transmitter increases with the energy employed to a much greater extent than with the Marconi connection, and can be increased by employing greater capacity or higher potentials. (2) The oscillations of the transmitter are not dangerous. (3) Insulation of the transmitter is not so important as with Marconi connections. (4) The oscillations in the primary circuit are but slightly damped, and those in the transmitter still less so; consequently, if the two circuits be brought to resonance, the amplitude of the oscillations becomes very large. (5) The arrangement fulfils the fundamental conditions for tuning between a transmitter and receiver.

Particulars are given of experiments in signalling, made with a view to comparing the author's arrangement with Marconi's. With inductive excitation signals were transmitted from Cuxhaven to Heligoland, a distance of 63 km., with masts 29 and 31 m. high, while with Marconi connections not a single signal was observed. The author mentions a method of tuning by concentrating the energy on the receiving appartus. G. H. B.

1465. *Telephone Switchboard, M. 99, of the German Post Office.* (Elektrotechn. Zeitschr. 22. pp. 382–384, May 2, 1901.)—This switchboard, which is very extensively used, is designed for 50 subscribers with complete metallic circuits; it is, however, arranged so as to work with earth returns for some of the subscribers, this being effected by means of a double plug and jack, from which insulating sleeves are taken when it is desired to work with an earth return. Diagrams of connections and photographs of the apparatus are given in the original paper. C. K. F.

1466. *Combination Switch for Telephone Intercommunication Systems.* **L. Montillot.** (Electrician, 21. pp. 179–182, March 23, 1901.)—This switch is devised by I. Tournaire, and replaces jacks, plugs, cords, and lever commutators. A plunger, with a vulcanite head, works in a socket of ivorine, and, when pressed home against the spring which spirally encircles it, makes, against the bottom contact, the requisite movement for putting a battery current in circuit for the call. Upon releasing the plug or plunger it resumes its normal position. To select one of the four circuits for which it is adapted, the vulcanite head is turned round to the requisite position, a double spring under or on the base of the switch moving round simultaneously and engaging the brass terminals allotted to the various lines. An arrow mark is engraved on the surface of the vulcanite head, which shows the position at any time of the switch spring within. In order that this spring may not overrun the contacts, by an incautious turn of the head or button, a small projecting hook or nose, attached to the stem of the plunger, rides over a small stud at each quarter turn of the button and settles into position between two adjacent studs when the movement is complete. Thus the operator is made sensible, by this snap action, of the proper contacts being effected. This switch can evidently be used at a central station from which branch lines radiate, or for intercommunication purposes. E. O. W.

REFERENCE.

1467. *Central Battery Telephone System.* **H. André.** (Ind. Élect. 9. pp. 545–548, 1900. Paper read before the International Electrical Congress at Paris.)—Description in general terms of the Western Electric Company's Central Battery Telephone System, with comparison between the old and new systems. [See further Abstract No. 330 (1901).] J. E. K.